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INSTRUMENT Practice AUTOMATION & ELECTRONICS

Vol. 13 No 8. Published Monthly August 1959

WORTH ITS WEIGHT IN GOLD-

($4\frac{1}{2}$ lbs.)

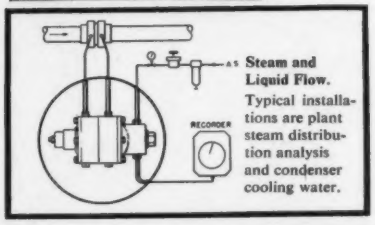
but so inexpensive

Taylor

DIFFERENTIAL PRESSURE TRANSMITTER

The 200TD111 Differential Pressure Transmitter is for the measurement of flow, liquid level, pressure or density of fluids. A 3 to 15 psi pneumatic signal is transmitted with an accuracy of 1%.

Ranges 0 to 50, 100, 200, and 300 inches of water.



Steam and Liquid Flow. Typical installations are plant steam distribution analysis and condenser cooling water.

LOW COST . EASILY INSTALLED
LIGHT WEIGHT . FIXED RANGE
SIMPLIFIED MAINTENANCE

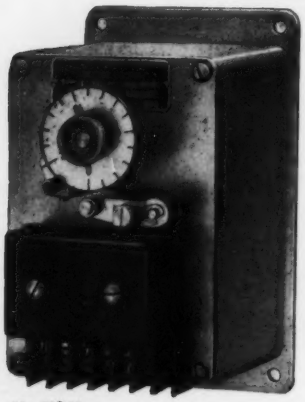
Contact Taylor NOW *for bulletin No. 98274/GB*

Taylor Controls Limited Hale End Road, Walthamstow, London, E.17
Telephone : Larkswood 3371/6
A subsidiary of the Taylor Instrument Companies, Rochester, N.Y., U.S.A.

OCT 16 1959

Circle 1 for further information

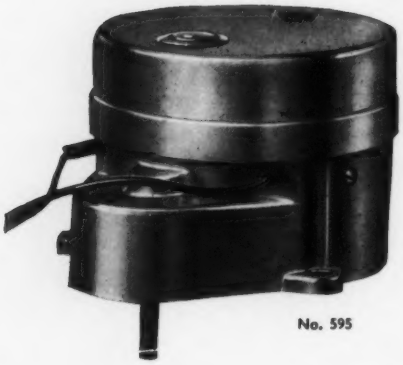
Circle 2 for further information



No. 503 M

every type of movement

for scientific instruments



No. 595

Meters	POINTERS
Electric clocks	DIFFERENTIALS
Telephones	PINIONS
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Gauge movements	WHEELS
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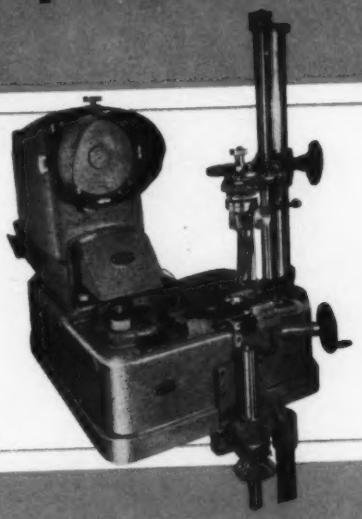
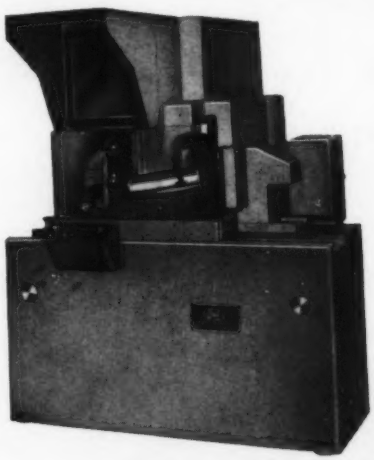
ITALY Carlo Caglioni Société Industrielle de Sonceboz, S.A., Ufficio di Milano, Via Mac. Melloni 70, Milano
U.S.A. Alina Corporation, 122 East Second Street, Mineola, L.I., N.Y.

OMT projection pantometers

for rapid, accurate checking of turbine blades and 3D contours



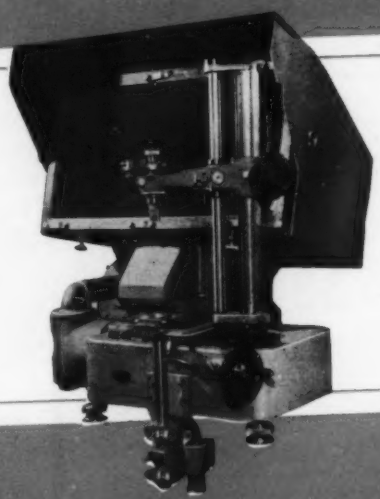


STANDARD MODEL

Developed for production department inspection of turbine blade sections and their relationship to angular position and alignment with blade root, this instrument has a capacity for blades up to 16" long by 3" wide and 1" thick. Magnification of the optical system is 30x.

MODEL E

Of identical capacity to the standard model, this instrument is designed for checking experimental and similar work requiring frequent changes in blade profile and provides a magnification of 10x on a 24" x 12" screen.



MODEL O.R. 1586

This large capacity pantometer, accommodating blades up to 24" in length, 6" chordal width and 2" thick, provides means for checking contour and size of any predetermined section together with section displacement and twist. Principal operational movements are power controlled to reduce inspection time.

ONE OF THE NEWALL GROUP

Precision products of
OPTICAL MEASURING TOOLS LIMITED
MAIDENHEAD

Full details on request to

NEWALL GROUP SALES LTD

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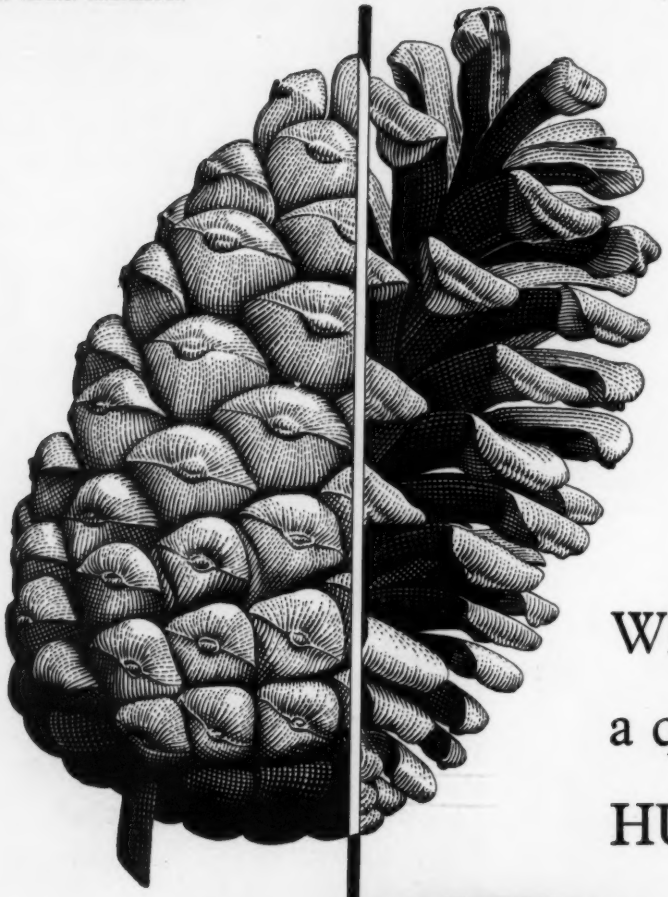
MAIDENHEAD TELEPHONE 3704

P108

Circle 4 for further information



When it's
a question of
HUMIDITY

consult . . .

NEGRETTI & ZAMBRA

Manufacturers of instruments for the indication, recording, controlling of:— Temperature, pressure, liquid level, volume specific gravity, humidity, etc. Also meteorological and aircraft instruments.

NEGRETTI & ZAMBRA LIMITED,
122 REGENT STREET, LONDON, W.1
Telephone: REGent 3406. Telegrams: Negretti, Piccy, London.
BRANCHES: Birmingham, Cardiff, Glasgow, Leeds, Manchester, Nottingham.
Agents or Subsidiaries in most countries.

Circle 5 for further information

FROM THE RANGE OF *Advance* SERVICE INSTRUMENTS

WIDE RANGE
150 k/cs to 220 M/cs

RELIABLE ATTENUATION

MOVABLE CURSOR
FOR ADJUSTING CALIBRATION

--- and at the right price

£38
NETT PRICE
in U.K.

TYPE SG62

WIDE BAND SIGNAL GENERATOR

Here is another "Advance" contribution to quicker and more efficient servicing—a signal generator with a phenomenally wide range covering all carrier and intermediate frequencies used for sound and television.

Note the features, remember the "Advance" reputation for reliability, consider the modest price—surely the finest value for money yet offered in its sphere,

Send for fully descriptive leaflet No. C45

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Advance COMPONENTS LIMITED

GD75 — INSTRUMENTS DIVISION

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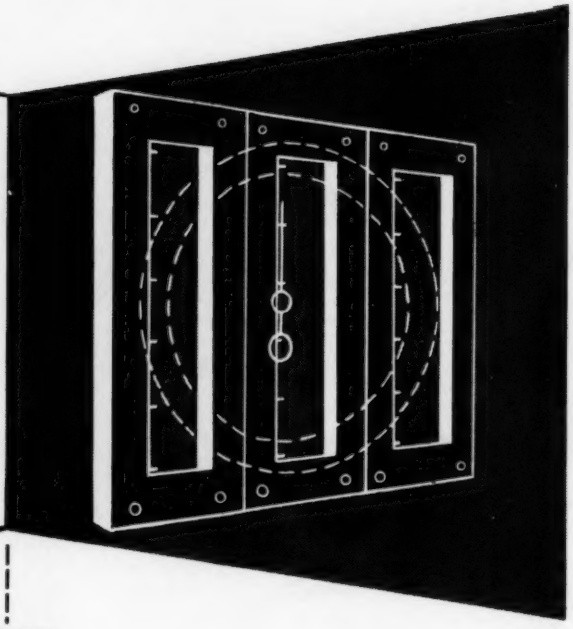
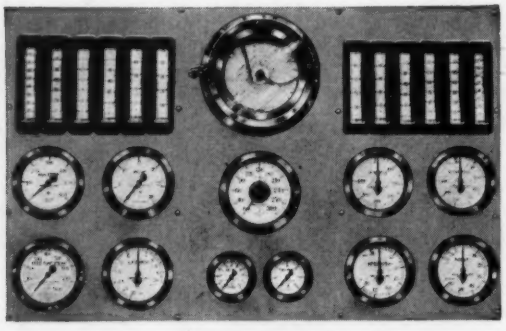
Save Panel Space

FIT
SYDNEY SMITH
FLAT-FACE EDGEWISE
PRESSURE GAUGES

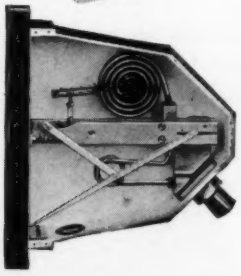


" GRASSHOPPER " PATENT
Size 8" in accordance with B.S.S. 1780-1951.



The TWELVE Edgewise Gauges in the panel above occupy approximately **HALF THE SPACE** *of the ELEVEN conventional dial type.*

Being Flat-Faced there is no Glint



SYDNEY SMITH & SONS

(NOTTINGHAM) LTD., · BASFORD WORKS, · NOTTINGHAM
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THE OLDEST PRESSURE GAUGE MAKERS IN THE WORLD

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PHONE: SLOANE 7294/5 *GRAMS: WHITCHAM SOWEST, LONDON*

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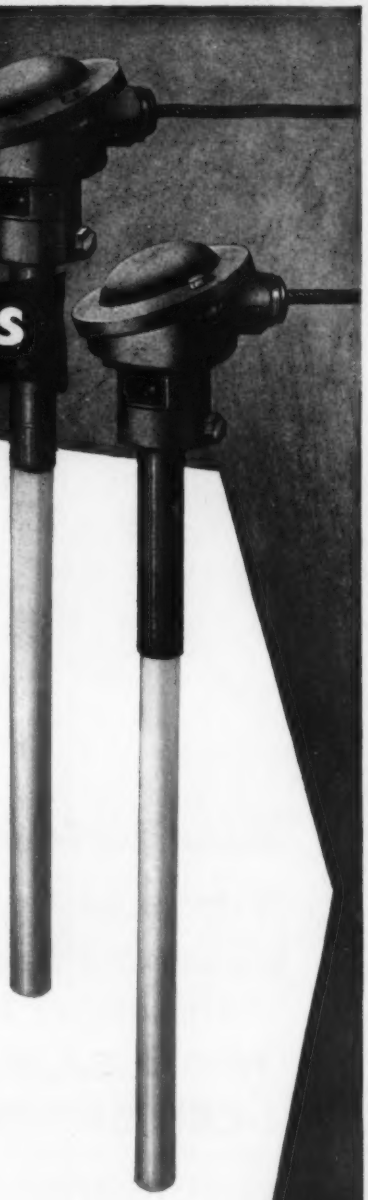
High Temperature

THERMOCOUPLE ALLOYS



"Ni-Cr (plus) v/s Ni-Al (minus)"

Conforming to B.S. 1827:1952

The Thermo-electric properties of the Nickel-Chromium/ Nickel-Aluminium Alloys "Ni-Cr(Plus)" and "Ni-Al (Minus)", are in strict conformity with those stated in the American National Bureau of Standards Circular 561, and British Standard Institution Reference Tables for Thermocouples, B.S. 1827:1952.

For Compensating Cables and Extension Leads in Civil and Military Aircraft, "Ni-Cr(Plus)"/"Ni-Al(Minus)" Wires have Ministry of Supply (Air) type approval, for Cables manufactured to Specifications EL. 1705 and 1632.

LOW TEMPERATURE THERMOCOUPLE WIRES:—

CONSTANTAN v PURE IRON
CONSTANTAN v H.C. COPPER

We manufacture a special quality of Thermocouple iron and are able to supply matched wires in the Iron v Constantan combination to meet customers' varied Thermal-EMF requirements. Furthermore, and of infinitely greater importance, we are able to guarantee the reproducibility of those thermo-electric properties.

When ordering Compensating Leads from your usual supplier, for greater accuracy specify: "Thermocouple Wires made by A. C. Scott & Co. Ltd., preferred".

A. C. SCOTT & COMPANY LIMITED

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dmAS29

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2 CHANNELS FOR THE SPACE OF ONE

The New Twin Quadrant Fader
introduced at the
1959 R.E.C.M.F. EXHIBITION
...and now in production

2 Networks in panel cut out 5" x 1 13/32"

Channel cueing by colour changing illuminated translucent scales.

Plug-in networks.

Three change-over auxiliary switches available on each network.

The New Twin Quadrant Fader for all Sound and Vision Studio Applications.

ELCOM

Designed and Developed by

ELECTRONIC COMPONENTS

WEEDON ROAD, INDUSTRIAL ESTATE, NORTHAMPTON

Phone; Northampton 2467 & 1873 Grams: Elcom, Northampton

protects flame-traps

from the dangers of blow-back flames

Circle 9 for further information

ETHER FLAME-TRAP ANCILLARY UNIT

Patent applied for

TYPE 350

This new safeguard, the ETHER Flame-Trap Ancillary Unit, Type 350, will be invaluable in industries where pre-aerated gas or pre-mixed gases are used. At present, a flame-trap is normally provided to arrest the flame temporarily when a blow-back occurs, but unless it is noticed, the flame will ultimately burn through the flame-trap.

Now this hazard need no longer exist. The ETHER Type 350 introduces a detector in front of the element of the flame-trap by means of which the supply of gas is shut off, or an alarm given, within a fraction of a second of a blow-back occurring.

The Type 350 is foolproof, compact and low in price. It can readily be adapted to fit all existing flame-traps. Illustrated technical data forwarded on request.

ENQUIRIES, SALES & SERVICE:

Combustion Safeguard and Solenoid Valve Division

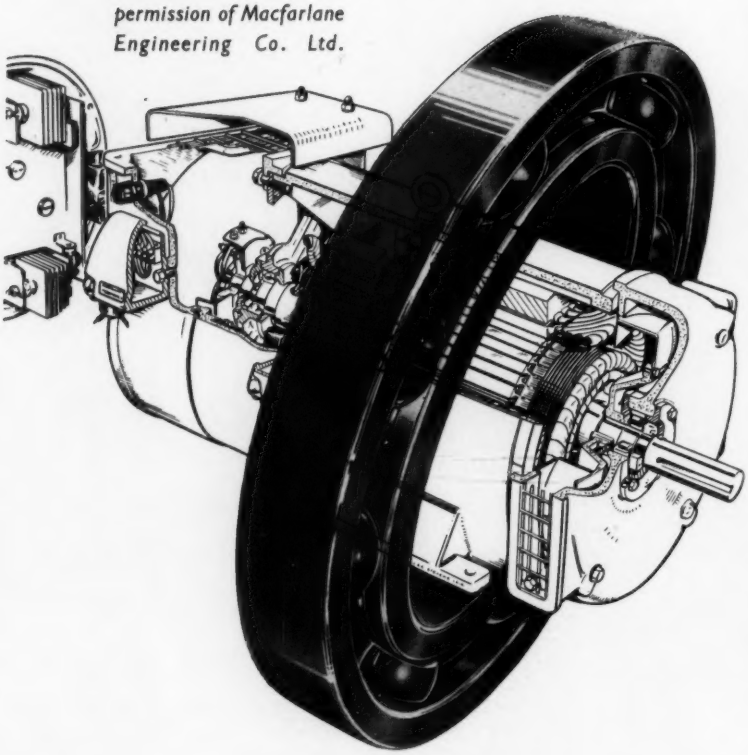
Caxton Way, Stevenage, Herts : Stevenage 2110-7
Tyburn Road, Erdington, Birmingham, 24 : East 0276-8
Representatives throughout U.K.; agents in all principal countries.

ETHER LIMITED

Circle 10 for further information

ANOTHER LINKED SUCCESS

Illustration by kind permission of Macfarlane Engineering Co. Ltd.



Again Hoffmann have assisted in yet another success—this brushless alternator manufactured by the Macfarlane Engineering Co. Ltd., is the very first of its type in the country, and is fitted with Hoffmann bearings.

Being brushless, this machine has eliminated the usual copper and carbon dust associated with brushes; also, moving parts have been reduced to the combined rotor in its bearings—Hoffmann, which will reduce frictional drag to the very minimum.

Specify Hoffmann the designer's choice

HOFFMANN **BALL & ROLLER BEARINGS**

THE HOFFMANN MANUFACTURING CO. LTD., CHELMSFORD, ESSEX

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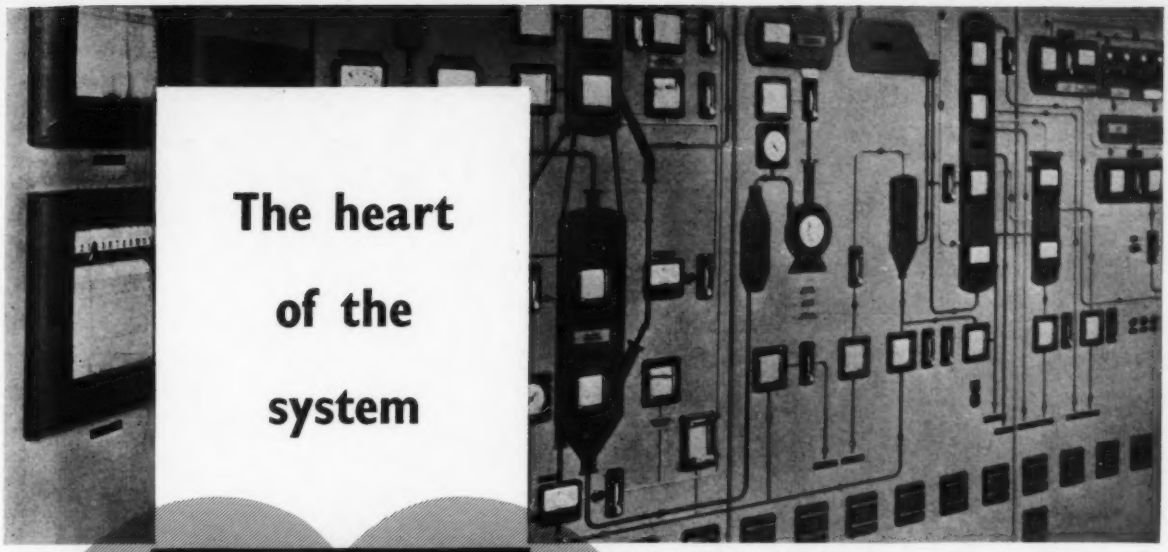


The heart of the system

For measuring flow, pressure or displacement there is no sensing device like the differential transformer used in Autronic transmitters. Simple, robust, with no moving parts or delicate components to be affected by shock or corrosion in hazardous positions, it provides exact electrical gauging of small mechanical movements with infinite resolution and high performance, it has low impedance with linear signal output, and it can add, subtract or average signals . . .

. . . just one example of the outstanding advantages of the Swartwout Autronic Control systems

Swartwout *Autronic* CONTROL SYSTEM

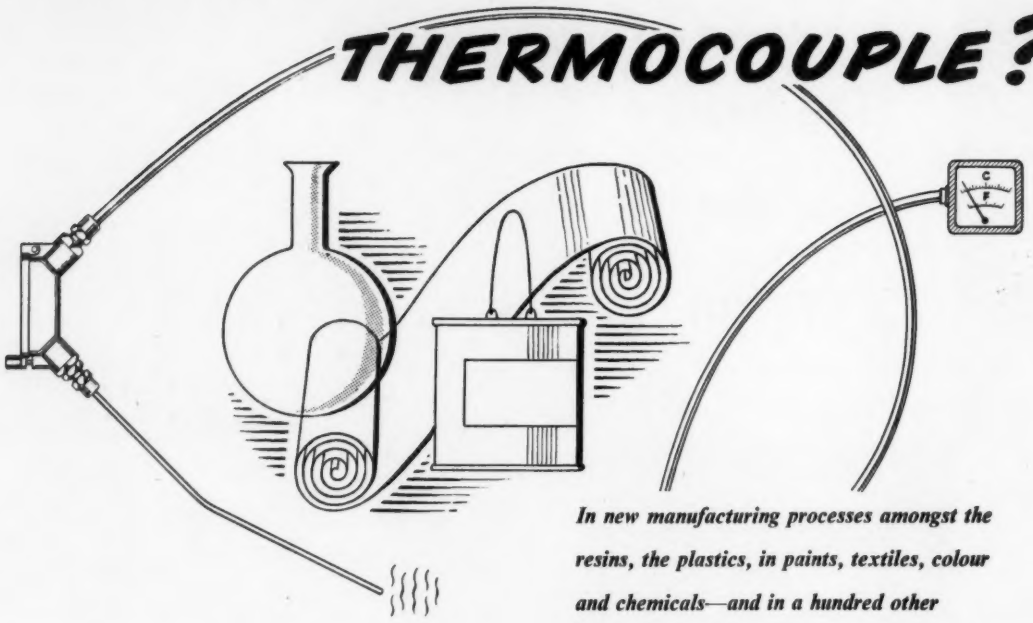
THE SWARTWOUT COMPANY LIMITED

CENTURY WORKS, LEWISHAM, S.E.13

A MEMBER OF THE ELLIOTT-AUTOMATION GROUP

Circle 12 for further information

What do you expect of a THERMOCOUPLE?



In new manufacturing processes amongst the resins, the plastics, in paints, textiles, colour and chemicals—and in a hundred other spheres—temperature control is playing a bigger and more vital part.

Higher accuracies, quicker responses, longer life —these are the demands imposed by today's thermo-instrumentation. And, these too, are the inherent features of 'Pyrotenax' Thermocouples. Add to these the characteristics shown and you have the reasons why 'Pyrotenax' Thermocouples are the considered choice of the scientist and technician behind such projects as Bradwell and Calder Hall etc. and other famous enterprises in Industry.

'Pyrotenax' Thermocouples are supplied with conductors of COPPER/CONSTANTAN with either CUPRO-NICKLE or MILD STEEL sheath, conductors of NICKEL-CHROME/NICKEL ALUMINIUM ALLOY with NICKEL-CHROME STEEL sheath for high accuracy, high temperature applications.

Full Technical details in Publication 31/U110

PERFECTED BY EXPERIENCE

Pyrotenax

m.i. THERMOCOUPLES

Use of the name "Pyrotenax" is exclusive to the products of this company and its associates.

✓	**EASILY BENT TO SHAPE**
	they are
✓	**IMMUNE FROM THERMAL SHOCK AND MECHANICAL DAMAGE**
	their
✓	**SMALL OVERALL DIAMETER** permits use in restricted spaces allowing simultaneous readings at different points, where normally only one conventional type could be sited, and generally
	NO ADDITIONAL PROTECTIVE SHEATHING REQUIRED
✓	*resulting in a*
	RAPID RESPONSE RATE
✓	comparable with that of mercury-in-glass thermometer
	They have a
✓	**LONG LIFE**
	but, because they are
✓	**INEXPENSIVELY REPLACED** they may be used at temperatures far in excess of those normally permitted for economic operation

PYROTENAX LIMITED HEBBURN-ON-TYNE *Telephone: Hebburn 83-2244/8*

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GD110

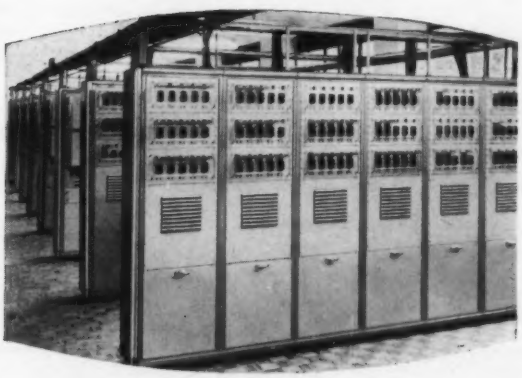
Circle 13 for further information

Photographs by courtesy of *The Exchange Telegraph Co. Ltd.*

Gathering and transmitting news so that it can be in print in an incredibly short time after the actual happening is one of the wonders of the modern age. It is yet another expression of today's demanding urgency for speed plus efficiency—two factors which largely determine the insistence for Carpenter Polarized Relays. That is why they are used in the Telegraph Line Transmitters operated by

The Exchange Telegraph Co. Ltd.

We will gladly co-operate with your technical department in development work involving the use of Relays.



TMC

CARPENTER POLARIZED RELAYS

TELEPHONE MANUFACTURING COMPANY LIMITED
Hollingsworth Works · Dulwich, S E 21
Telephone: GIPsy Hill 2211

Circle 14 for further information

Precision Electrical Measuring Instruments

BY Ernest Turner

Ernest Turner precision-built electrical measuring instruments give absolute accuracy, dependability and ease of reading and keeping pace with the ever widening field of electronics, Ernest Turner Electrical Instruments offer a wide range of instruments to meet specific requirements and individual applications. For more than 35 years, in this country and in many parts of the world, wherever there has been a job of precise electrical measurement to be done, the choice has been Ernest Turner instruments

Ernest Turner Electrical Instruments Ltd. HIGH WYCOMBE · BUCKS · ENGLAND

Telephone: High Wycombe 1301-2-3 *Cables: Gorgeous, High Wycombe*

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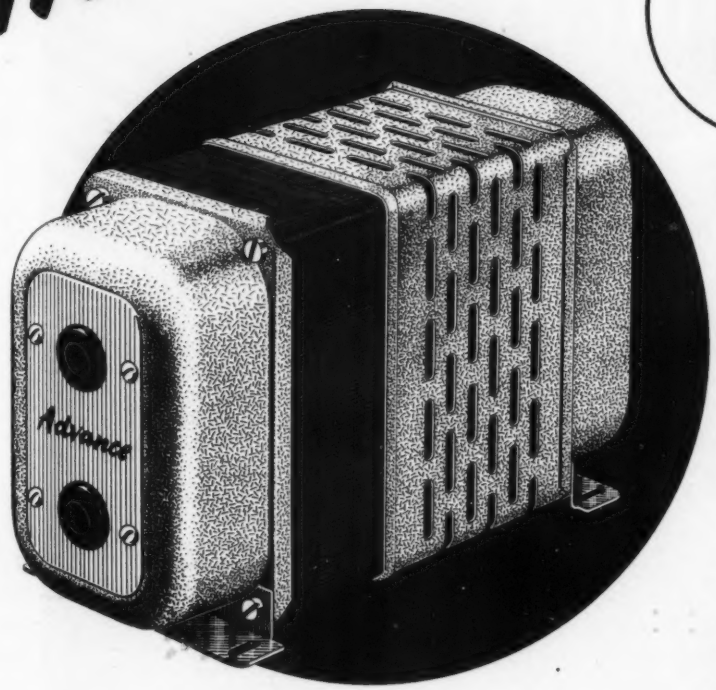
More WATTS PER £ lb



with the NEW
CV SERIES

Take the best in Constant Voltage Transformer design and practice . . . maintain all those features proven by years "in the field" . . . . add still greater efficiency . . . . reduce size and weight . . . . and then drastically cut the cost — and you have the NEW CV Series.

Models now available with output capacities of 25, 50, 75 and 100 watts and range of outputs from 6 to 240 volts — all providing assured output voltage regulation within ±1% for input variations of up to ±15%

- **WEIGHT REDUCED** by over 25%
- **SIZE REDUCED** by over 40%
- **STRAY FIELD REDUCED** by over 75%
- **OPERATE AT ANY LOAD** from 'NO LOAD' to 'FULL LOAD'
- **WILL OPERATE CONTINUOUSLY AT AMBIENT TEMPERATURES** from −10 to +50°C.

CONSTANT VOLTAGE TRANSFORMERS

They are **SMALLER - LIGHTER** *and* **COST LESS!**

Here's a typical example-

	MODEL CV.25/E	MODEL MT.281/E
Input Voltage	190-260V	190-260V
Output Voltage	6V	6V
Output Capacity	25W	25W
Dimensions	5½"x3 5/16"x4¾"	7"x5½"x4¾"
Weight	5lb	7lb
	PRICE £6.5.0	PRICE £8.0.0

Full details in Folder C63 available on request

by Advance – to be sure!

Advance COMPONENTS LIMITED

MAINS STABILIZATION DIVISION

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GD 80

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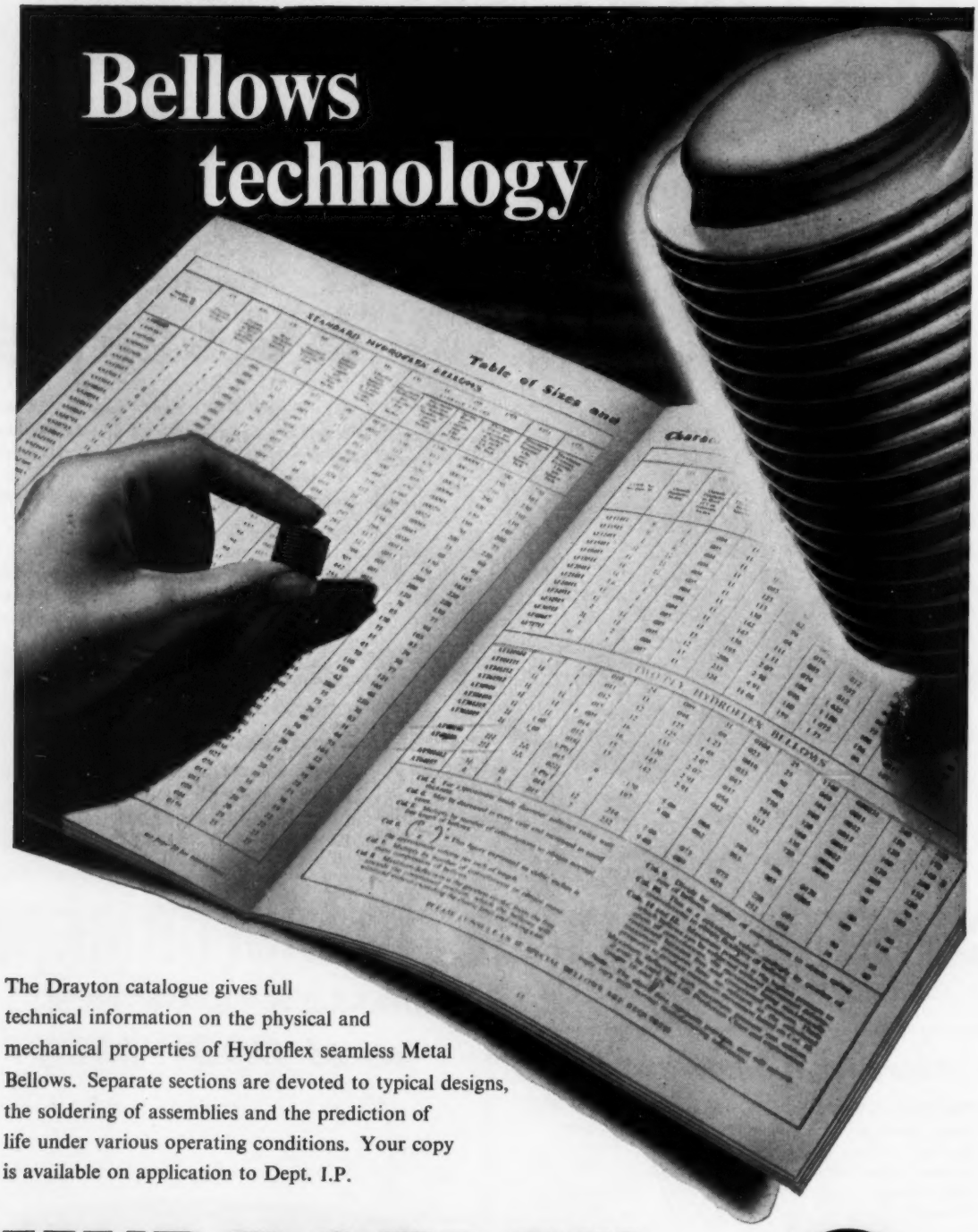
Bellows technology



The Drayton catalogue gives full technical information on the physical and mechanical properties of Hydroflex seamless Metal Bellows. Separate sections are devoted to typical designs, the soldering of assemblies and the prediction of life under various operating conditions. Your copy is available on application to Dept. I.P.

HYDROFLEX

seamless Metal Bellows

HYDROFLEX

B.26

THE DRAYTON REGULATOR & INSTRUMENT CO. LTD., WEST DRAYTON, MIDDLESEX *West Drayton 4012*

Circle 17 for further information

Finding relays a puzzle?

We're old hands at straightening out relay problems.

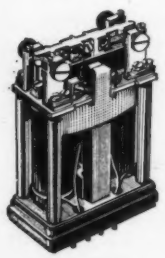
After all, we've been designing and making them for years (over 50 in fact)—big ones, little ones, sensitive ones, general purpose ones; open, dust protected and hermetically sealed, high current, low capacitance, high 'g'—in fact the lot.

We admit that we can't always come up with the answer off the shelf—who can with daily developments in electronics, radar, airborne equipment, nucleonics, reactor instrumentation, etc.? But all of these industries are continually finding Ericsson relays the perfect answer to their problems.

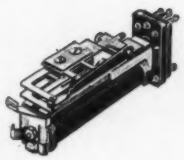
If you are stuck with a very special project and are behind schedule, let us lend you an expert hand.

Help us to help *you*—give us as much information as possible, for an early solution.

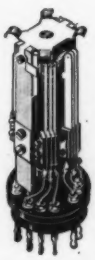
Here are a few of our current miniatures



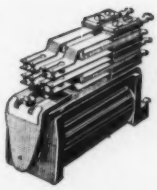
POLARIZED RELAY
Versatile, sensitive and stable. Available with one or two change-over contacts. Dust cover or hermetically sealed. Long or short frame models.



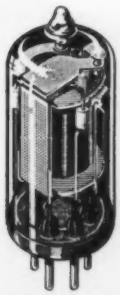
TYPE 1A RELAY
Highly sensitive—non-polarized type with balanced moving system for high 'g' performance. Hermetically sealed. With one change-over.



TYPE 2 RELAY
General purpose type with balanced moving system. Normal and heavy duty contacts up to 4 change-overs. Hermetically sealed.



G.P. RELAY
For general purpose applications. Multi-contacts up to 4 units. Open, dust cover or hermetically sealed with normal, heavy duty or low capacitance contacts.



MGL RELAY
Specially designed for electronic and nucleonic applications. One change-over contact. Fits B7G base. Also available with metal can.

Full details of these and other relays can be obtained from:

ELECTRO-MECHANICAL DIVISION
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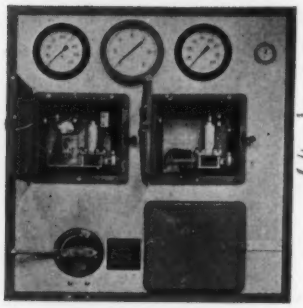
Circle 18 for further information

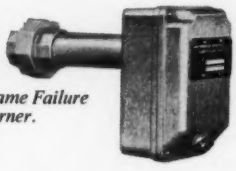
AUTOMATIC CONTROL



The control panel housing the pressure controls manual/automatic switch lever, pressure, temperature and draught gauges.

for
Water Tube boilers
Shell boilers
Marine boilers
Industrial processes
Heat exchangers, thermal and nuclear.

The John Thompson La Mont auxiliary boilers as supplied to the Alfred Holt shipping line are fitted with automatic controls by John Thompson Instrument Co. Pressure controls, high pressure cut-outs, flame failure and air flow controls are linked with multiple safety features to give a compact reliable system.



A John Thompson Flame Failure unit fitted to the burner.

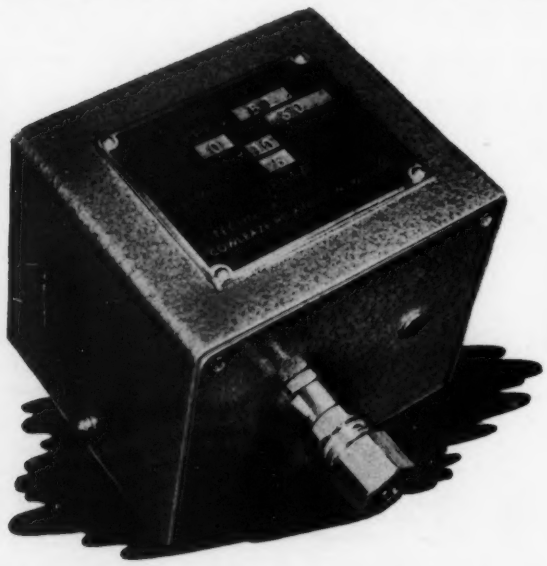
A section of the remote control, push-button unit showing some of the timers, relays and contactors.

JOHN THOMPSON INSTRUMENTS

JOHN THOMPSON GROUP

JOHN THOMPSON INSTRUMENT CO LTD · WOLVERHAMPTON

HE'S QUITE A HIGH PRESSURE SALESMAN . . .



. . . been making himself known all over the place lately. A very popular fellow, too, because people know that beneath that steel shell of his there beats a heart that never varies in its reliability and repetition accuracy. Of course, he *looks* just like any other pressure switch, but his friends know that he's unbeatable for simplicity, robustness and economy. You'd find him cheap at twice the price. Actually, he's one of a family of five pedigree pressure switches who cover between them a range from a few inches w.g. up to 300 pounds per square inch.

Another reason for liking him—he's so very adaptable. Whether you turn him into a vacuum switch or fit him with a calibrated scale, it's all the same to him. He'll not so much as bat an eyelid if you want him with an adjustable differential—or a fixed close differential, a mechanical unloading device or any variations in his electrical control arrangements. And as for loyalty, just stick him on the wall or on a panel and he'll serve you well for years.

Switch size 3½ in. × 3 in. × 3 in.

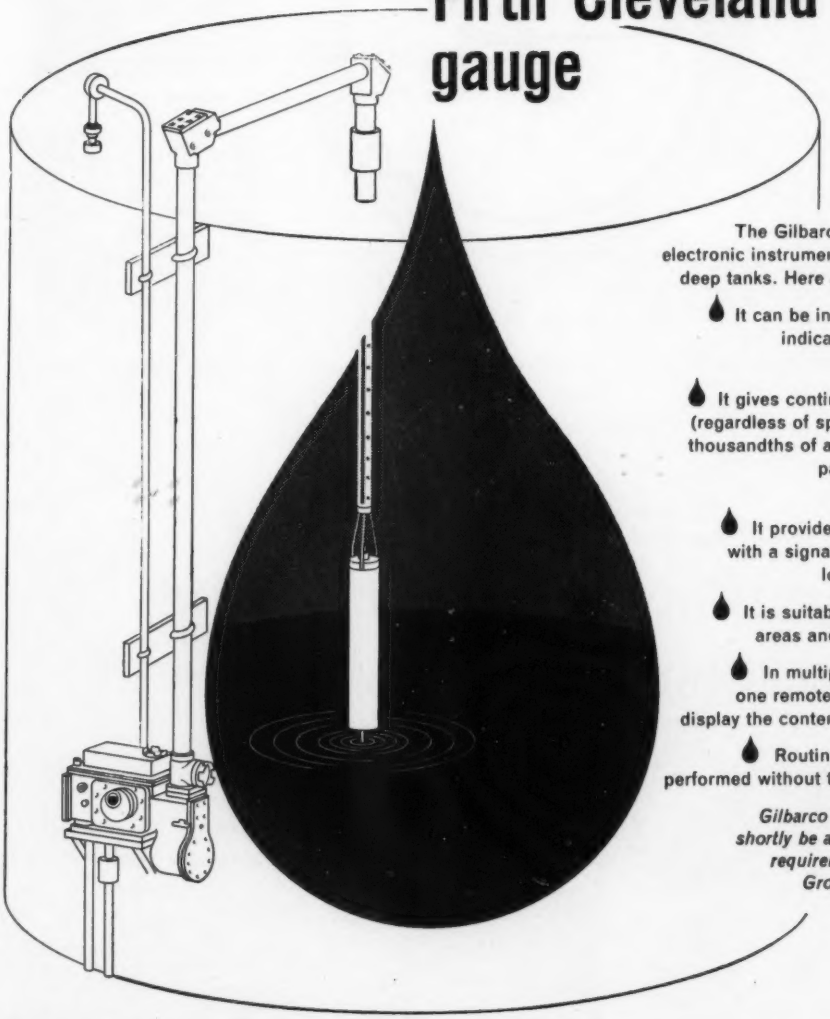
DELTA Technical Services Ltd.

COWLEAZE ROAD, KINGSTON-ON-THAMES, SURREY. **Telephone: KINgston 9568 (3 lines)**

Circle 19 for further information

Circle **20** for further information

this is the GILBARCO Firth Cleveland gauge



The Gilbarco Gauge is a highly accurate electronic instrument for indicating liquid level in deep tanks. Here are a few of its advantages:—

- It can be installed in tanks of all types to indicate liquid level or the interface between two liquids.
- It gives continuous readings of liquid level (regardless of specific gravity) to within a few thousandths of an inch of height—a feature of particular importance for tanks with large surface areas.
- It provides local and remote indication with a signal to operate data reduction or logging equipment if required.
- It is suitable for operation in hazardous areas and in extremes of temperature.
- In multiple storage tank installations, one remote indicator can be arranged to display the contents, in turn, of up to 50 tanks.
- Routine maintenance can be readily performed without taking the tank out of service.

Gilbarco Gauges of our production will shortly be available to Buxton flame-proof requirements or to American Class 1, Group D, Division 1 classification

Made under licence to Gilbert and Barker Mfg. Co., U.S.A. For full details write to:

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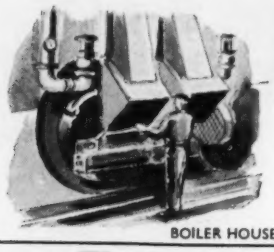
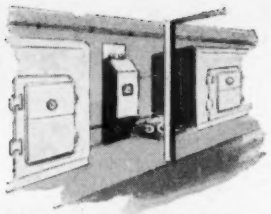
Rototherm

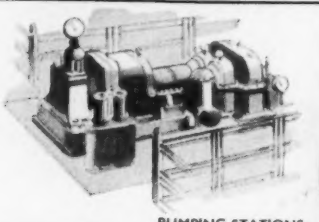
The DIAL THERMOMETER



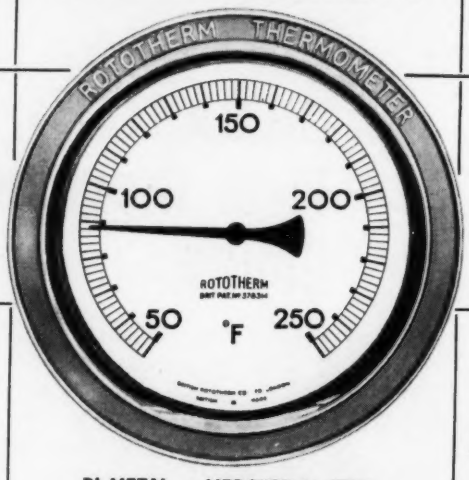
BOILER HOUSES

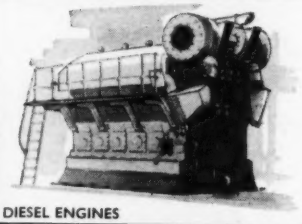


REFRIGERATION & COLD STORAGE

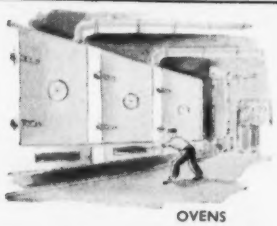


PUMPING STATIONS

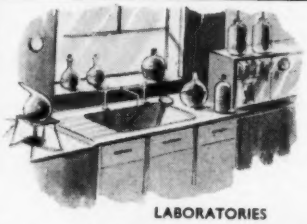




DIESEL ENGINES



OVENS



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Mercury Vapour Concentration Meter

Type E.3472

Measures concentration of mercury vapour present in air. Essential where quantities of mercury are regularly used or where danger exists of leakage of mercury vapour from apparatus.

Two sensitivities are available, at the touch of a switch, giving either full scale reading at a concentration of 770 micro-grammes per cubic metre of air or full scale meter reading at a concentration of 200 micro-grammes. Terminations are provided at rear for operation of a recorder to give continuous readings of concentration present.

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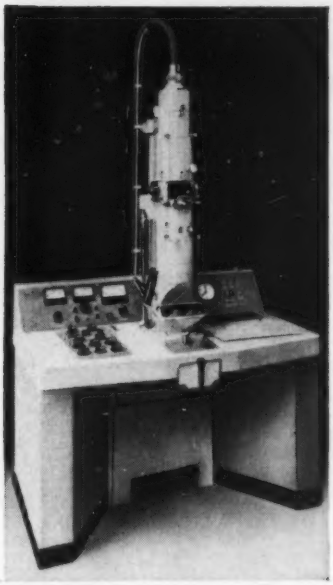
Circle 23 for further information

Scientific Means

The Metropolitan-Vickers Range of Scientific Equipments includes apparatus for the investigation of metallurgical, chemical and biological problems in research, production or processing. These equipments cover a wide selection of specialised scientific apparatus.



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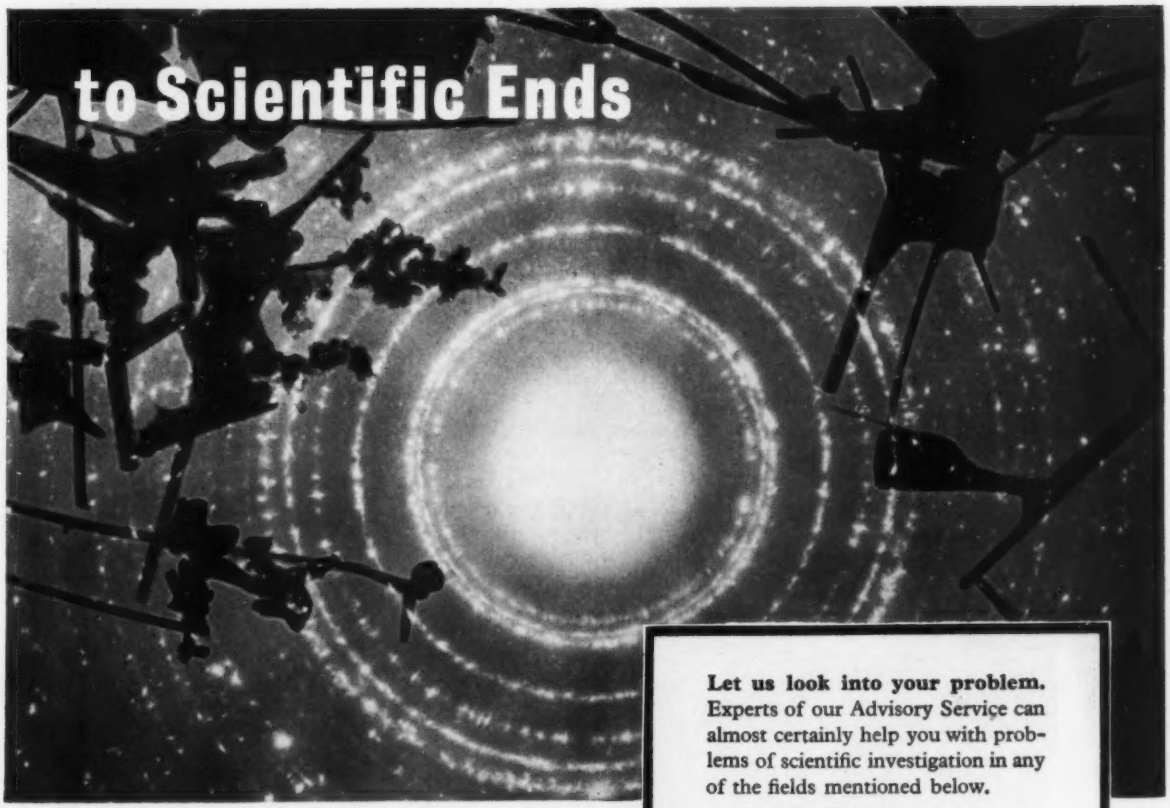

Information on crystal structure, particle size and shape. Illustration shows diffraction pattern of zinc oxide smoke superimposed on its electron micrograph.

Let us look into your problem. Experts of our Advisory Service can almost certainly help you with problems of scientific investigation in any of the fields mentioned below.

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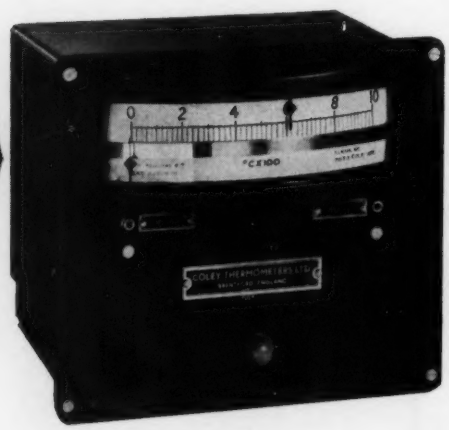
PYROMETER CONTROLLER

Embodying an extremely simple circuit without the use of any electronic components, transistors, lenses or reflectors, the Coley Z5 will control with an accuracy of ·25% at any temperature up to 1600°C.

Leaflet Z5 will tell you all about it.



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AUTOMATIC CONTROL of Pressure and Temperature

Electric contacts control relays which stop and start motors at pressures or temperatures which can be individually and accurately set. Intrinsically safe and flame-proof schemes are available. Please send for Catalogue Section 1D.

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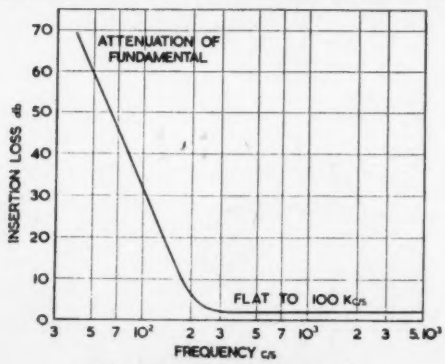
ELECTRIC WAVE FILTERS



The curve illustrates typical high pass filter characteristics

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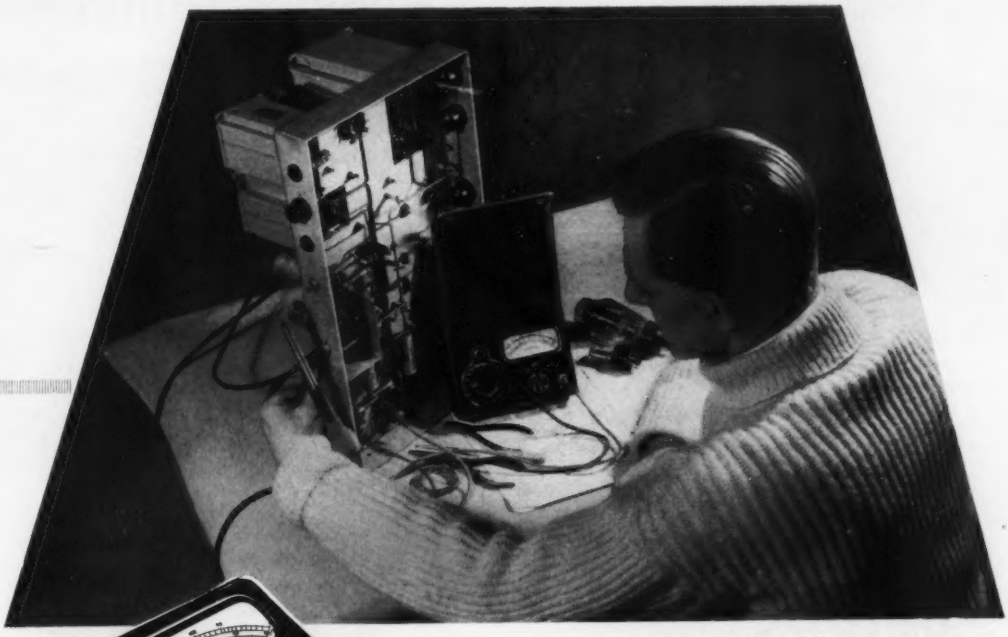

Using an AVO Multiminor to balance the D.C. component across the output transformer of a High Fidelity Amplifier.

THE MULTIMINOR

D.C. Voltage: 0-1,000 V in 7 ranges
A.C. Voltage: 0-1,000 V in 5 ranges
D.C. Current: 0-1A in 5 ranges
Resistance: 0-20,000Ω. 0-2MΩ

Sensitivity:
10,000Ω/V on D.C. voltage ranges
1,000 „ „ A.C. „ „

Accuracy:
3% of full scale value on D.C.
4% „ „ „ „ „ A.C.

THIS is an ingeniously designed yet inexpensive rectifier/moving coil instrument of pocket size and sturdy construction. It is extremely well made and simple to use.

It is fitted with a high-grade rotary selector switch of quite unique design, in which a series of 18 fixed silver-plated contacts, embedded in a moulded ring, are wiped by a double-contact rotor arm.

Full advantage has been taken of the latest printed resistor techniques to achieve compactness of size and economy of weight.

Specially designed, extremely accurate test gear has been made to ensure that every Multiminor measures up to the prescribed standards of accuracy, and the final testing is of a particularly rigorous nature.

Size: 5½ × 3½ × 1¾ inches.
Weight: 1 lb. approx.

List Price: **£9 : 10s.**

Complete with Test Leads and Clips
Leather Case if required **32/6**

Write for your Free Illustrated Catalogue describing the complete range of AVO instruments.

RANGE SELECTION :
Range selection is by means of a substantial switch, there being only two connection sockets for any measurement. The instrument has 19 ranges, a single scale being provided for current and voltage measurements and another for resistance measurements.

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Portable . . .

TYPE MC—1 (MK.III)

CONDUCTIVITY MEASURING BRIDGE

The type MC—1 portable electrolytic conductivity measuring bridge is a truly portable instrument designed to give long and trouble free service in the laboratory or in the field.

The instrument, which is now used by the Electricity Generating Stations and the principal Water Purification Engineers throughout the country, is supplied complete with an ELECTRONIC SWITCHGEAR patented, non-glass, conductivity measuring cell and all accessories, in a convenient hardwood carrying case. The development of low power consumption transistorized circuits, which operate from a small long life dry battery, has resulted in the production of a particularly compact and light-weight precision instrument.

The range of measurement is from $0{\cdot}1$—10^6 micromhos/cm^3.

Price
£66

DESCRIPTIVE LEAFLET MC AVAILABLE ON REQUEST

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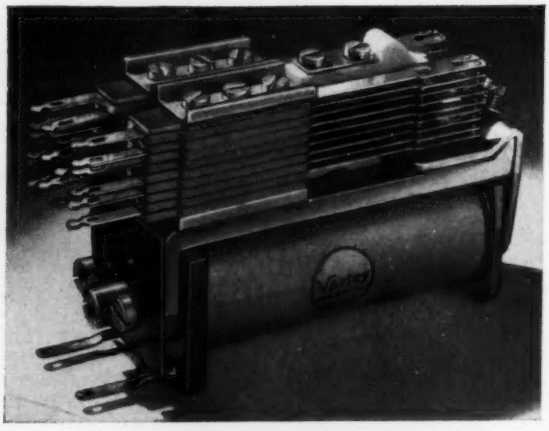
A name that means something!



Varley
REGD. TRADE MARK

P.O.3000 RELAY

. . . a name that means quality All VARLEY relays are built and adjusted to Post Office specification using new piece parts throughout.

COILS All values from .1 to 100 K.ohms can be supplied, also double and sandwich windings.

CONTACTS

TYPE	RATING	MAXIMUM NUMBER
Light Duty Twin Silver.	150V. 0.3 amps	8 M or B 8 C or K
Light/Heavy Duty Silver.	150V. 2.5 amps	8 M or B 4 C.
Light/Heavy Duty Silver.	250V. 2.5 amps	4 M or B 2 C.
Heavy Duty Elkonite.	150V. 5 amps	8 M or B 4 C.
Heavy Duty Elkonite.	250V. 5 amps	4 M or B 4 C.

A name that means promptness. Prototype samples can be supplied within 7 days—full production in 2-3 weeks.

For further details write to Dept. R.3

OLIVER PELL CONTROL LIMITED
Cambridge Row, Burrage Road, Woolwich SE18
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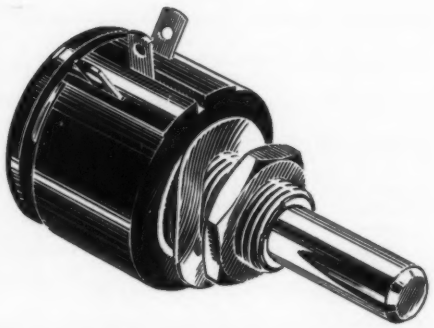
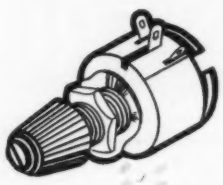
Circle 30 for further information

THE NEW POTENTIOMETER
Type PV2

This new miniature Wirewound Potentiometer is fully type-approved to R.C.S.C. styles RVW 13/14.





Illustrated are some of the styles available

RATING

2 watts at 20°C.

Available with normal shaft for knob operation, slotted shaft for preset adjustment by screwdriver, and longer slotted shaft with split collet locking device. All styles can be supplied with or without panel seals.

A wide air gap at the back of the component prevents condensation in humid conditions.

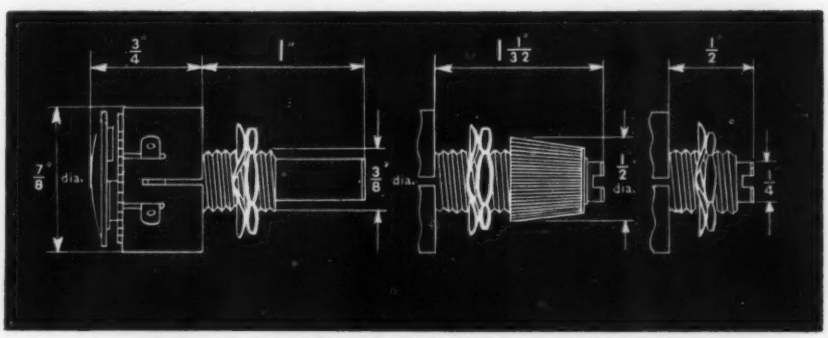
The resistance element is of copper-nickel wire for the lower values and nickel-chrome wire for the higher values; both are wound in strip form on a bakelite laminate of high electrical quality.

The resistance wire is welded at each end to an interwire, which is soldered to the connecting tag. The three tags are of plated brass and project through slots in the shell.

Contact ring and wiper arms, the tips of which are rhodium plated, are nickel silver. Shaft bush and nut are nickel-plated brass.

The lockable shaft model has a long bush with split conical extension at the end. The shaft is locked by a milled sleeve screwed over the bush compressing the split cone.

Write for technical leaflet



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KINGSTHORPE NORTHAMPTON
Tel: 32354/7 Telegrams: 'Ceil, Northampton'

Circle 31 for further information

process timers
cyclic timers
delay switches

for automatic process control

part of a special sequence control panel

A full range of high accuracy electronic timers (for periods up to 5 minutes) enable many processes to be left to carry on automatically.

Repetitive accuracy is ± 2%.

While the Elcontrol single and cyclic units are very useful, a complete sequence panel may be more so.

Let us help you towards the full benefits of automatic process control.

Appointed Agents	*Telephone*
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N. WEST: A. M. Lock & Co. Ltd., Union St., Oldham.	*Main 6744*
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write to **ELCONTROL LTD., HITCHIN, HERTS.** *Hitchin 2411*

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NEW A MARCONI

GENERAL-PURPOSE OSCILLOSCOPE TF 1330

- D.C. to 15 Mc/s pass band
- 50 mV/cm sensitivity
- ·02 μsec/cm writing speed
- 10 kV e.h.t. for bright clear trace
- Direct-reading time and voltage calibration independent of X-expansion or Y-gain

BRIEF SPECIFICATION

Y Amplifier BANDWIDTH: D.C. to 15 Mc/s. RISE TIME: ·025 μsec. SENSITIVITY: Seven ranges, 50 mV/cm to 50 V/cm. AMPLITUDE MEASUREMENT: 2% accuracy. INPUT: Two switched coaxial inlets. Impedance: 1 MΩ, 30 μμF. *Optional probe: 10 MΩ, 7 μμF.* DISTORTIONLESS SIGNAL DELAY: 0.25 μsec.

X Amplifier BANDWIDTH: D.C. to 2 Mc/s. EXPANSION: Up to at least × 5. EXTERNAL INPUT: D.C. coupled; 1 MΩ, 25 μμF.

Sweep Generator SWEEP VELOCITY: 15 ranges, 0.1 μsec/cm to 1 sec/cm at minimum expansion. TIME MEASUREMENT: 2% accuracy. TRIGGER SELECTION: A.C. coupled, D.C. coupled, TV field sync, or Automatic.

General TUBE: 5 inch, spiral accelerator. POWER SUPPLY: 200-250 and 100-150 V. WEIGHT: 48 lb. PRICE (complete): £300, F.O.B. U.K. port.

Please send for leaflet AM 154.

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North: 23/25 Station Square, Harrogate Telephone: 67455

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TC 154

Circle 32 for further information

Circle **33** for further information

ANY CASE

Cases? Consoles? Open, enclosed, F/V or I/V Raks? Electrical cubicles? Choose from the widest range of expertly designed 'standards' and save money. Usually, Imhofs can supply the case you want **from stock** plus a variety of chassis, panels and strong, good-looking handles

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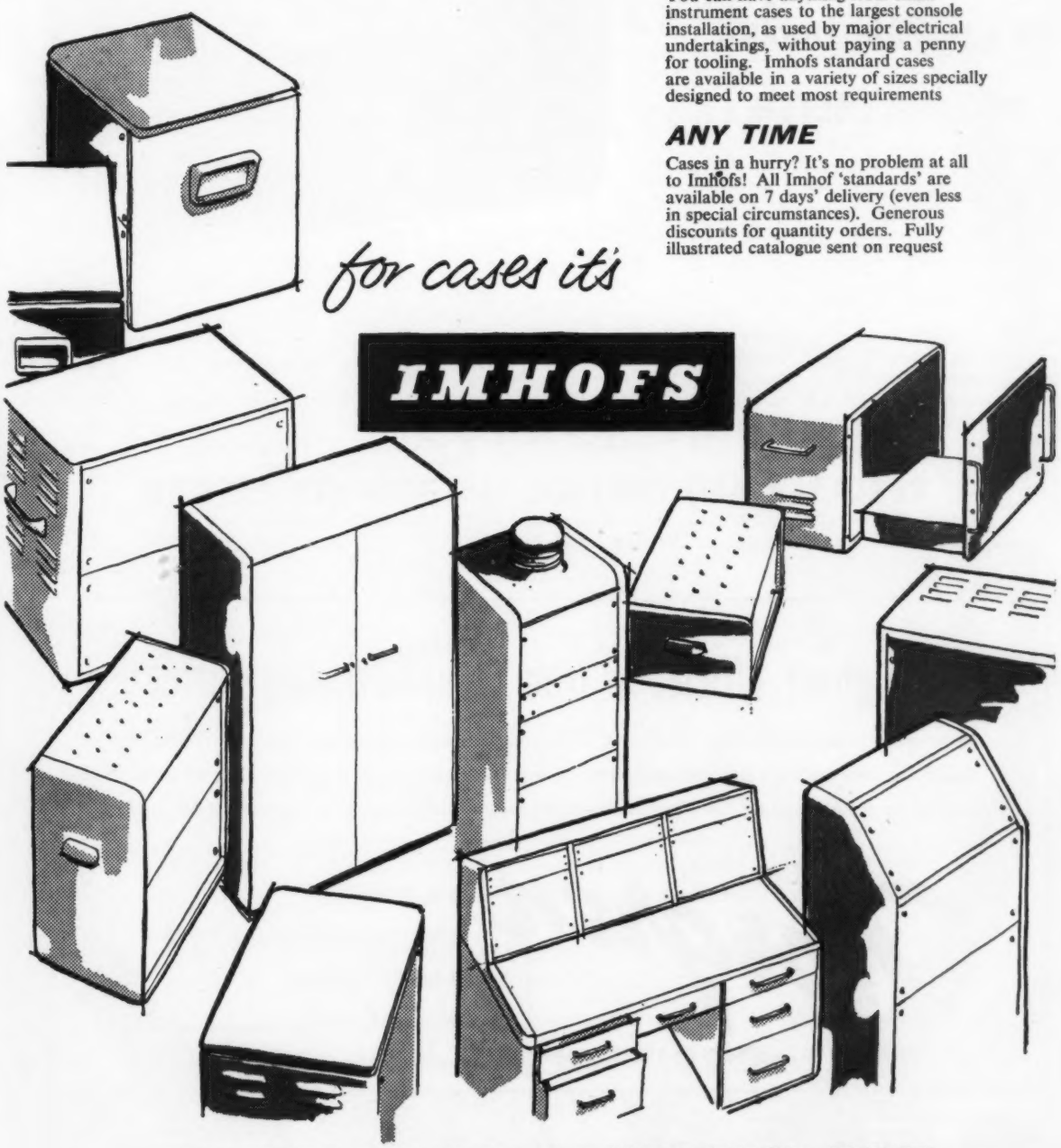
You can have anything from small instrument cases to the largest console installation, as used by major electrical undertakings, without paying a penny for tooling. Imhofs standard cases are available in a variety of sizes specially designed to meet most requirements

ANY TIME

Cases in a hurry? It's no problem at all to Imhofs! All Imhof 'standards' are available on 7 days' delivery (even less in special circumstances). Generous discounts for quantity orders. Fully illustrated catalogue sent on request

for cases it's

IMHOFS



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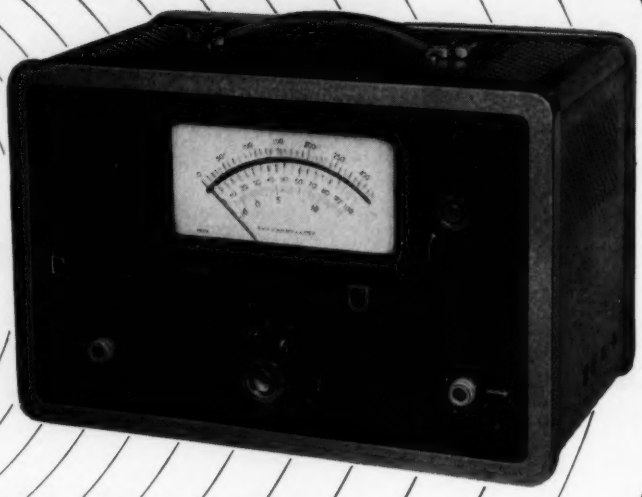
Circle 34 for further information

THE PHILIPS GM.6012 BROADBAND MILLIVOLTMETER



Eminently suitable for measurements in the acoustical and ultrasonic fields, electrical measurements of mechanical vibrations, measurements on I.F. and A.F. amplifiers and measurements on carrier telephone installations.

Technical data

Measuring ranges: 1 mV — 300V f.s.d. dB scale from — 80 dB . . . 52 dB O dB = 1 mW in 600 Ω (0.775 V).

Frequency range: 2 c/s...1 Mc/s

Overall accuracy: 20 c/s...100 kc/s ± 2.5%. 2 c/s...1 Mc/s better than ± 5%.

Input impedance: 1 mV...3 V range 4 M Ω parallel with 20 pF. 10 V...300 V range 10 M Ω parallel with 10 pF.

Mains supply: 110-245 V. 40-100 c/s.

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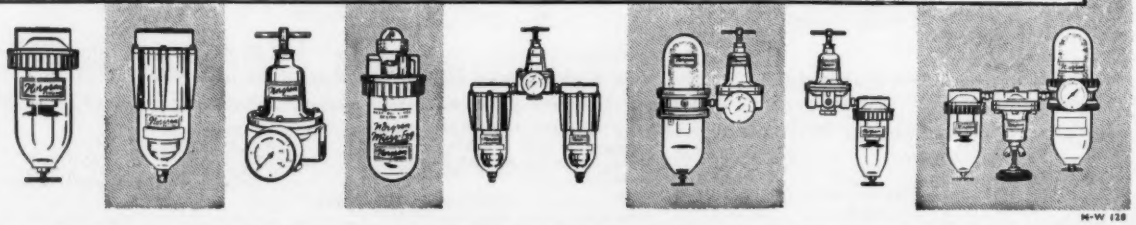

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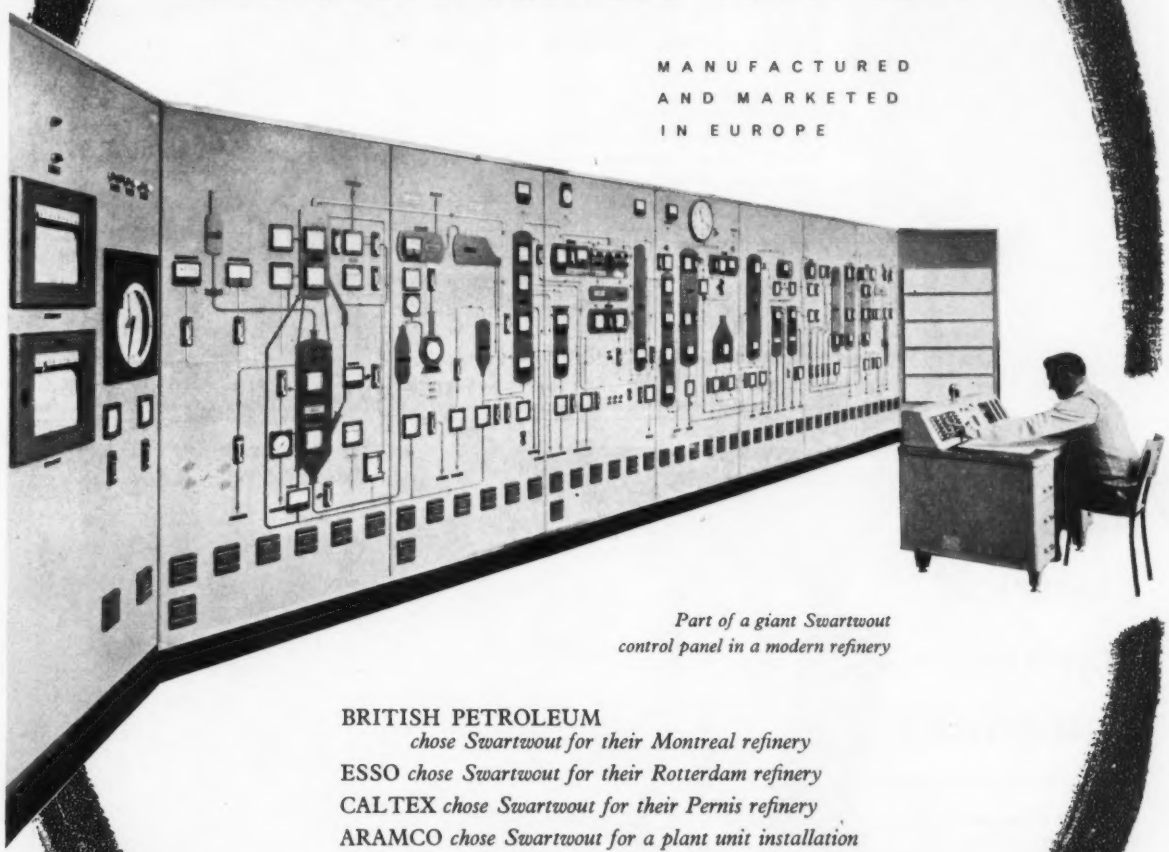

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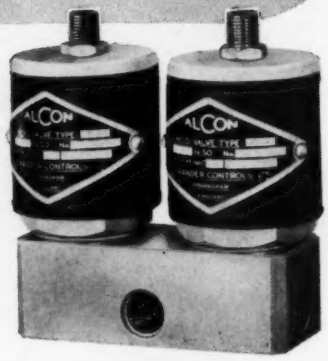

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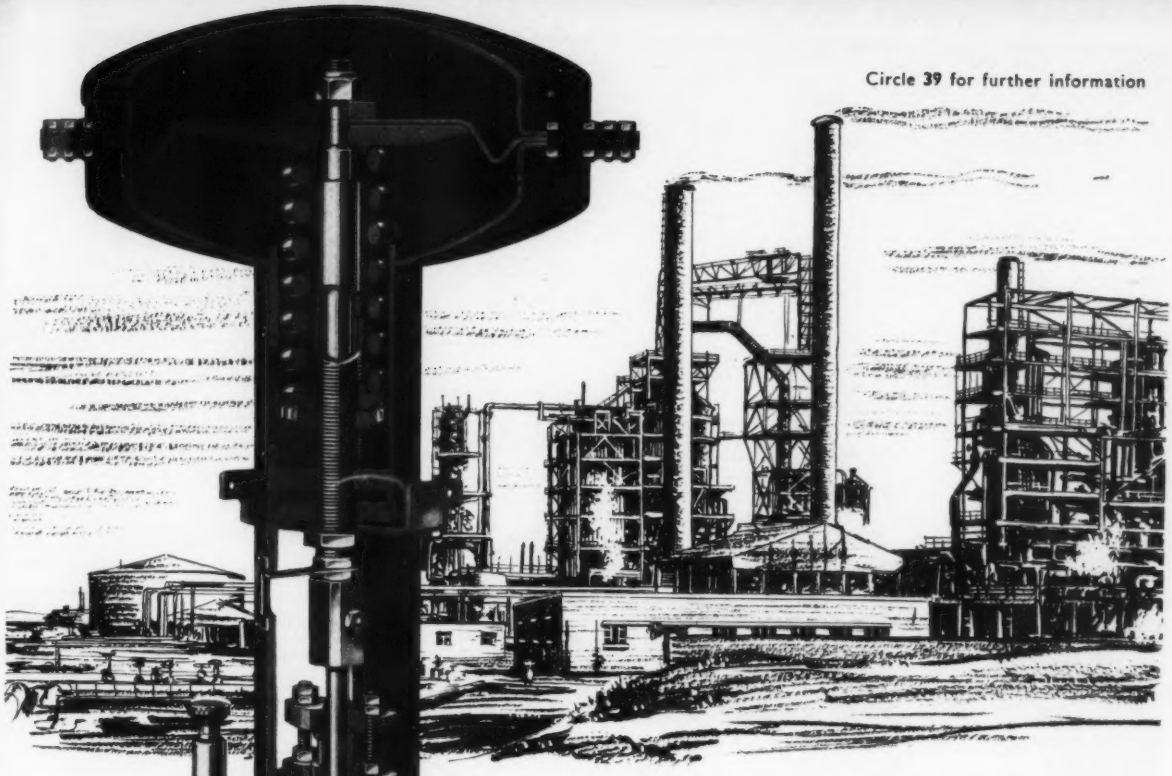

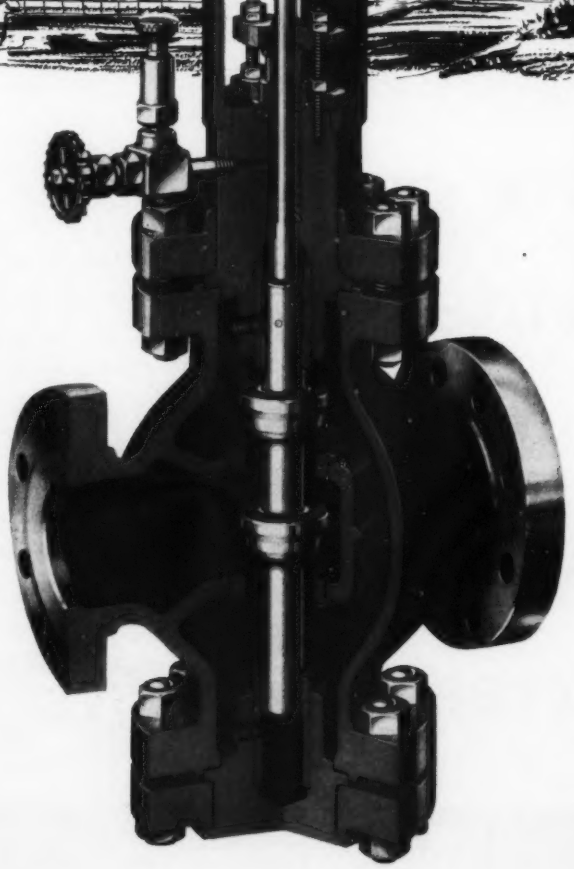

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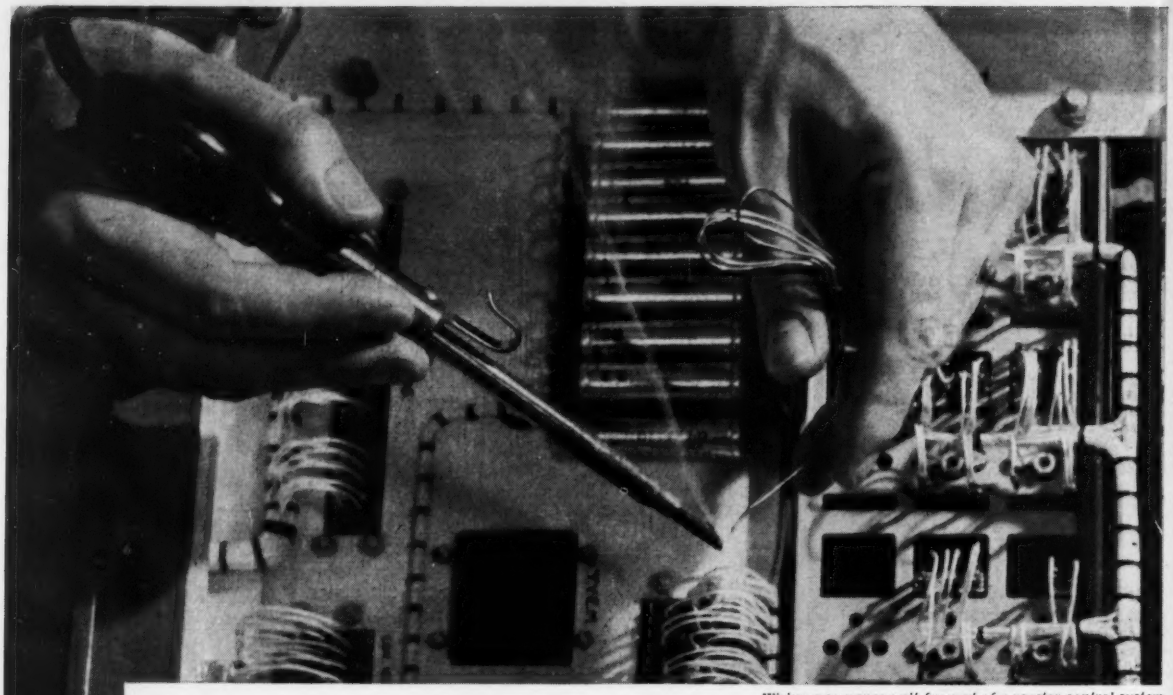

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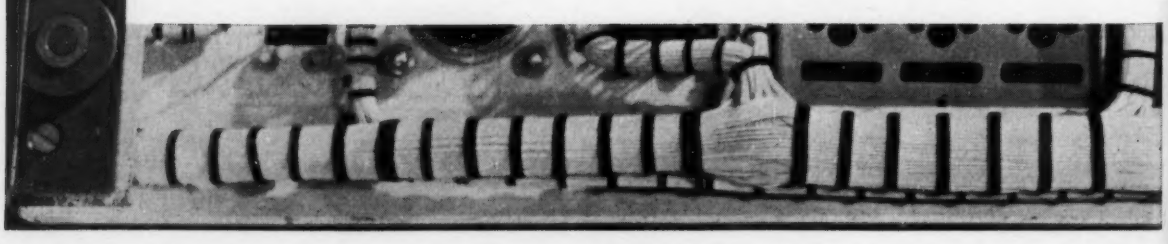

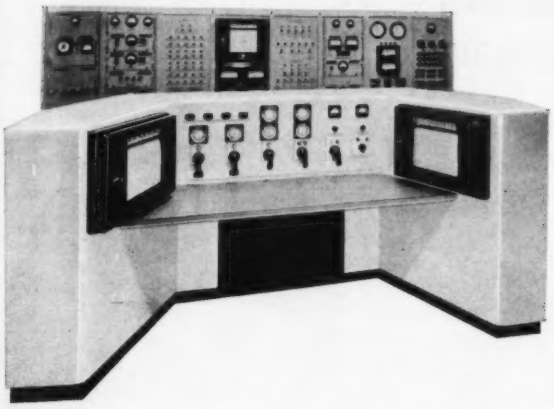

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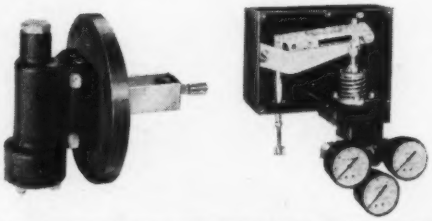

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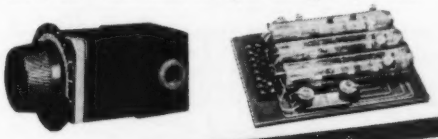

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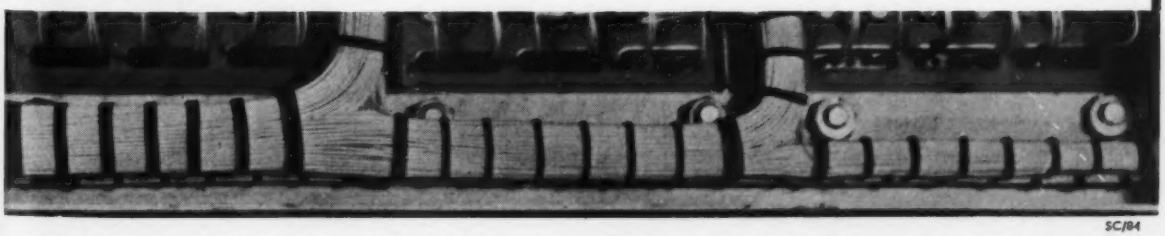

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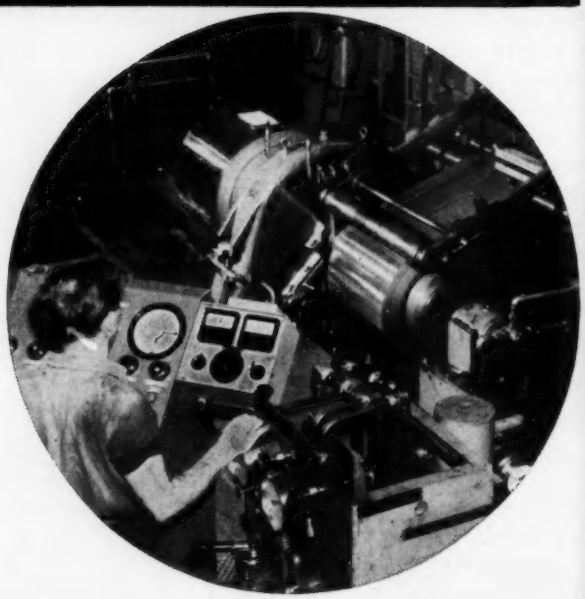

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Editor: J. T. Miller, B.Sc., F.Inst.P.

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VOL. 13. No. 8

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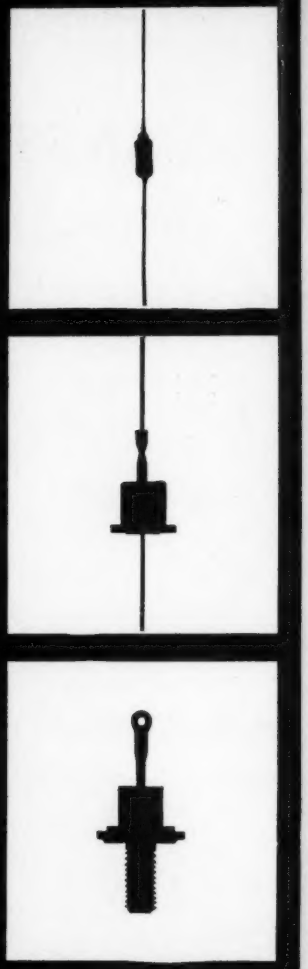

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Average Rectified Forward Current at +50°C	I_o	750mA	750mA	† 400mA	† 400mA	*3A	*3A
Average Rectified Forward Current at +150°C	I_o	250mA	250mA	150mA	150mA	*1A	*1A
Recurrent Peak Forward Current at +50°C	i_1	† 2·5A	† 2·5A	† 1·25A	† 1·25A	*10A	*10A
Surge Current for 10 Milliseconds	I_{FX}	16A	16A	6A	6A	33A	33A
Operating Temperature, Ambient	T_A	—65°C to +150°C					
SPECIFICATIONS							
Minimum Breakdown Voltage at +150°C	V_z	240V	720V	240V	720V	240V	720V
Maximum Reverse Current at P.I.V. at +25°C	LI_b	10μA	10μA	0·2·μA	0·2μA	10uA	10μA
Maximum Forward Voltage Drop at +25°C	E_b	1·0V (I_o=500mA)	1·0V	1·0V (I_o=400mA)	1·0V	1·1V (I_b=1Amp)	1·1V

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INSTRUMENT Practice
AUTOMATION & ELECTRONICS

We regret that owing to the printing dispute this issue appears late.

We intend publishing all the monthly issues and hope to get back to our normal publication date by the October issue.

COMMENTARY

The Metric System

"I have long been convinced that ultimately the United States must shift to the metric system. Outside of our Anglo-Saxon culture, practically every nation has made this shift during the past 150 years or so. Every country has found it possible to adopt the metric system . . ." This is a quotation from a talk given recently by Mr. Lewis L. Strauss, Secretary of Commerce, to the American Physical Society. Mr. Strauss goes on to summarise the advantages of adopting the system. He states:

"The advantages of the metric system would be many in addition to ease of calculation and conversion. Most of our daily measurements would become more accurate. Book-keeping and computational requirements would be reduced. Our international trade, our buying, and our selling, and many of our international aid and security programmes would be facilitated. The metrological divorce between our science, research and development and our industrial programmes would be overcome.

There is absolutely no doubt, the conditions of our times—the increasing importance of science for all phases of life as well as the increasing interdependence of nations through security, travel, communications, exchange, aid and trade—all require a convergence on one system of measurement.

The force of science and technology as well as the needs of the international economy will require the change. Science exerts an ever stronger impact on our society—and the language of science is couched in metrical terms. The more computer techniques come into significant use—and before this audience I need not predict the future role of such computational techniques—the greater will become our need for an efficient system of measurement."

The reference to the metrological divorce between the scientific and engineering worlds draws attention to the biggest problem involved. In the Anglo-Saxon speaking countries, generally, both the metric and the English systems have become firmly established in their relevant spheres. Difficulties involved in conversion to the one system, whilst not insurmountable, would be very great. On the other hand, our own sustained efforts to promote free trade areas in Europe must logically cause us to think increasingly in terms of the metric system. The adherence to the two systems leads to curious anomalies, an example of which may be found in the field of weighing instrumentation. At one end of the scale, balance manufacturers supply instruments in which the weights are invariably in grams and fractions of a gram. At the other end of the scale we have weighing systems calibrated in terms of pounds, hundredweights or tons. It is perhaps in the industrial measurement and control field that one realises the nature of the problem. Flows are measured in cubic feet, pounds or gallons per unit of time. Pressures are expressed in pounds per square inch. Densities are required in pounds per cubic foot or cubic inch (or, sometimes, grams per cubic centimetre!). A vast number of instruments have been installed calibrated in these units. What happens if the metric system is adopted? Does one envisage a brand new instrument panel with flow meters calibrated in cubic metres per second alongside one with calibrations in cubic feet per second? Another problem one might consider is that of replacements of individual instruments except in terms of the original calibration units. Yet it is a subject which cannot be lightly brushed aside in a world which seems to be veering more and more to the metric system, and in which we may find increasing export trade.

Exports to the U.S.S.R.

The recently issued publication GEN 4988, of the Export Services Branch of the Board of Trade, lists possible export items to the U.S.S.R. under the five-year trade agreement. The total envisaged is from 4 to 4·5 billion roubles or 350-400 million pounds. Direct instrumentation seems to occupy a relatively low percentage of this sum and the value appears to be small when spread over five years. Control valves are listed at 40-50 million roubles. Control and measuring instruments are included with radio and television equipment and the value of this group appears to be about 90-100 million roubles. It is obvious, however, that much of the plant specified must include its own instrumentation, so that the actual value of instruments involved will be somewhat higher than the figures quoted.

This article describes an unusual and important example of closed loop control

The Control of Large Electric Arc Furnaces

1. Introduction

ELECTRIC arc furnaces are now being employed on an increasing scale for the production of steel. For many years only small furnaces were available and were used almost exclusively for the production of high-grade alloy steels. However, with the development of large furnaces of 40 tons capacity and upwards, the electric furnace has become a serious competitor to the open hearth furnace. Where electricity is cheap, the trend is to replace existing open hearth installations with electric furnaces of 100 tons capacity and over, and up to 45 MVA rating.

In direct arc steel melting furnaces, the inherent instability and non-linear nature of the arc pose peculiar problems for the supply and control engineers. Some of the problems are discussed in this paper, together with methods for overcoming them.

2. Power System Limitations

The problems associated with the control of large arc furnaces will be better understood if consideration is first given to the nature of the arc furnace load and its effect on the supply system.

2(*i*) *Arc Furnace Load*

It is well known that an a.c. electric arc is a non-linear circuit element requiring an impedance in series to stabilise the current, the magnitude of which depends on arc length and other factors.

For small furnaces, reactors must be added in series with the supply transformer, but in the majority of large arc furnace installations the inherent reactance of the transformer and the flexible cables is sufficient to stabilise the arc. In the broadest sense, the insertion of reactance enables the arc to be maintained providing the arc conditions are static, such as constant length and atmosphere.

In a steel melting furnace, however, conditions are far from static. During the melt-down period the arc length will vary erratically due to scrap movement and the ionisation of the atmosphere surrounding the arc will be affected by sudden temperature fluctuations, or by chemical impurities in the metal, etc., being vaporised by the arc. These changes in ionisation may vary the electrical conductivity of the arc by up to 50% for periods as small as a few milliseconds.[1] American measurements of cyclic variations of arc current of the order of 2 to 8 per sec, with amplitudes up to ±25% of the set current, occurring during the melt-down period, have been confirmed in large furnaces in Great Britain (Fig. 1) and the theory has been put forward that the variations are due to mechanical and electromagnetic forces acting within and external to the arc. Intensive research work is being done on this subject in Great Britain and the U.S.A.[2, 3]

High current surges, in many cases limited only by the short circuit reactance of the system, occur during "cave-in" conditions after the electrodes have "bored" a path through the scrap. Surges may last up to a few seconds depending on the depth of the hole which has been "bored", and the maximum speed of the electrode control system.

Surges of any character are undesirable from the point of view of the power supply, the transformer, and the average power input to the furnace. In Great Britain a great deal of work is being done on investigating the character of the surges developed in large furnaces and on methods for producing a more stable arc and more efficient electrode control systems, some of which will be discussed later.

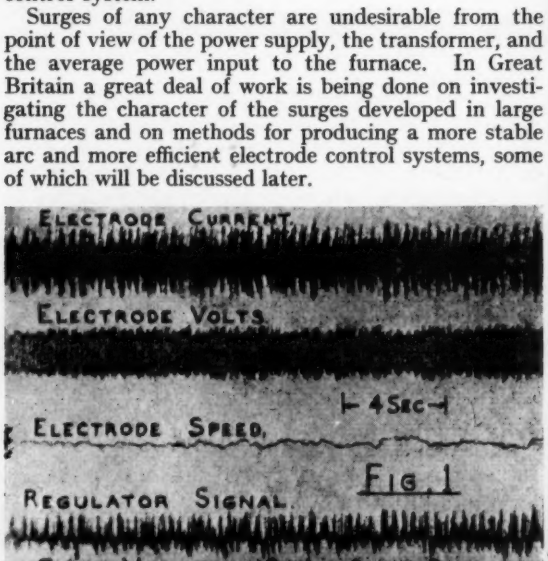


Fig. 1. *Cyclic variations*

By J. W. S. PAYNE, B.Sc.(Eng.), A.C.G.I.*

ırnan Relation to Their Effect on the Supply System

2(*ii*) *Voltage Fluctuation and Light Flicker*

Unless the furnace is supplied from a supply system with infinite short circuit capacity, current surges occurring in the furnace will cause voltage, power factor and possibly frequency variations on the supply system, the magnitude depending on the effective reactance of the supply system at the furnace transformer. For inter-connected supply systems fed from many alternators, machine reactance and inertia may be neglected, but for systems fed from a few alternators, machine reactance may have to be taken into account.

For cyclic surges occurring several times a second, the transient reactance is usually accurate enough, but, for surges lasting for more than a second, the alternator voltage regulator may operate to correct the system volts with a consequent overvoltage when the surge collapses.

In one extreme case, where the furnace load formed a large percentage of the supply system load, frequency variation was found troublesome, mainly due to the inherently poor response of the regulator on a hydro-alternator. Where lighting loads are fed from a point in the system near the furnace, light flicker may become objectionable, the effect being dependent on magnitude, frequency and thermal inertia of the light source. It is, however, generally agreed that the worst frequency occurs at about 5 cycles per second. This is within the band produced by the cyclic surges described above. Any method which can produce a more stable arc is, therefore, of paramount importance.[3]

Work being done in the U.S.A. has indicated that in general, for tolerable light flicker at 110 volts, the lighting load should not be connected to the supply system at a point which has a fault MVA rating of less than 100 times the furnace rating.

In Great Britain investigations on the same subject are proceeding but due to the lower thermal inertia of 230 V lamps, figures of 200 times the furnace rating may be considered desirable. In many cases this would lead to providing additional corrective equipment such as series capacitors and synchronous condensers which would make the furnace installation an uneconomic proposition. More information is still required to enable accurate limits to be defined.

2(*iii*) *The Effect of Long Transmission Lines and High Line Reactance*

In countries such as South Africa, arc furnace loads may be at the end of a long transmission line. If the system is operating near its stability limit, the fluctuations in line load caused by the furnace may result in a lower allowable loading for the system unless corrective measures are employed.

High line reactance may also cause the furnace to run below its optimum power input with consequent increased running costs and may also render electrode control more difficult.

3. Performance Required of Electrode Control Systems

3(*i*) *Smelting and Refining Furnaces*

In general the electric smelting furnace combines the effects of resistance heating and submerged arc heating. The ore, etc., may or may not be conducting except in the locality of the arc and in some processes the arc has to be initiated by artificially short circuiting the electrodes with carbon rods.

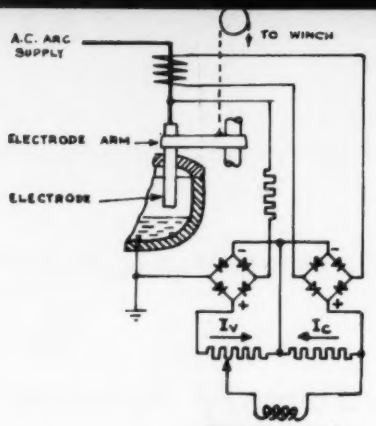
The electrodes are usually of the Soderberg type, weighing up to 50 tons, and remain buried during the process.

The requirement of the electrode regulator is to maintain a constant heat input to the furnace, but due to the conditions given above, except at the commencement of the melt, fast response from the electrode regulator is seldom required—the main requirement being absolute reliability.

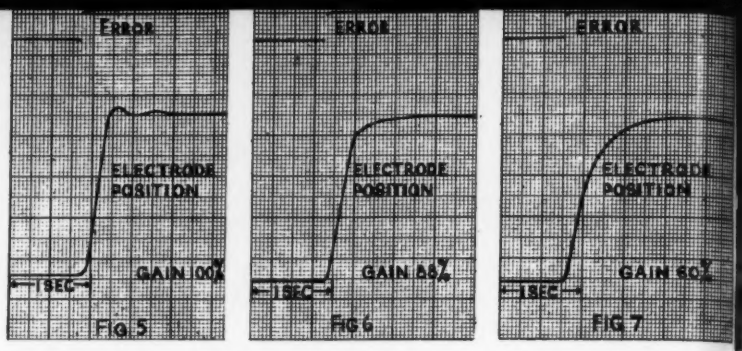
3(*ii*) *Direct Arc Melting Furnaces*

The fundamental requirement of the electrode control systems for melting furnaces is the same as for smelting furnaces but due to the conditions discussed in section 2 the arc conditions are far less stable. As soon as melting starts there are frequent and sudden shifts of the charge. To maintain the arc at a constant length the electrodes must be made to follow these

*Industrial Engineering Department, Associated Electrical Industries, Heavy Plant Division



◀ *Fig. 2. Simplified diagram of impedance balancing circuit*



▲ *Figs. 5 to 10. Electrode regulator responses obtained from analogue computer study*

disturbances very rapidly and under cave-in conditions must have as high a velocity as can be tolerated without causing overshoot or electrode breakage.

It is impossible, even with the fastest system, to follow the condition at the commencement of a melt when the relatively cold charge drops suddenly away. The arc may be broken and the electrode must follow down at limited speed to avoid electrode breakage on impact. At the instant of striking the metal, full sensitivity and maximum available velocity must be regained. In view of the recent theories on arc fluctuations, referred to above, this form of arc instability may even be increased by a regulator which has a response time within the natural frequency of the arc. Such a regulator may tend to increase the frequency of current variations to the most undesirable frequency from the point of view of light flicker. Investigation into this possibility is proceeding.

4. Existing Types of Arc Furnace Regulators

In any 3-phase arc furnace the problem is to control the rapidly fluctuating input power. This is most easily done by positioning the electrodes to give a constant arc impedance. The metal charge acts as a common neutral for each of the three phases involved and any change in arc impedance in one phase will affect the current in the other two phases. Where current alone is used as the control element, instability may occur in regulators with fast responses.

However, if the voltage between the electrode and the charge is used as an additional control signal and balanced against the current signal (Fig. 2), for small errors this will result in a form of impedance control which gives a more stable regulation. This has proved very successful in practice.

4(*i*) *Electrical Regulators*

The electrodes are, in most cases, raised and lowered by means of direct-current electric motors of robust mill-type construction. The electrodes may be counterbalanced mechanically by weights or pneumatic cylinders. Alternatively, static torque balance may be provided by circulating a small current in the winch motor armature.

For smelting furnaces where the duty is light, contactors may be used to control the winch motors, but for melting furnaces the contactors limit response and the large number of operations give rise to excessive maintenance. The fast response needed requires peak forcing currents in the motor armature of up to five times the rated full-load current and is best obtained by using a rotating machine. This may be a rotating amplifier such as an amplidyne, or for large power outputs a generator, specially designed for high rates of rise of current and voltage. The rotating amplifier will have sufficient dynamic amplification in its two stages to give the required response without any prior amplification of the current and voltage signals. The generator will, however, require an amplifier to provide forcing on to its fields. This may be an electronic, magnetic or rotating amplifier. An all-static system utilising magnetic amplifiers supplying induction motors is an alternative which provides an extremely reliable system, but due to the torque and inertia limitations of the induction motor the speed of response is limited.

4(*ii*) *Electro-Hydraulic Regulators*

Hydraulic regulators have been used successfully for many years in Europe and many detailed variations in

Fig. 3. Typical arc furnace position regulator

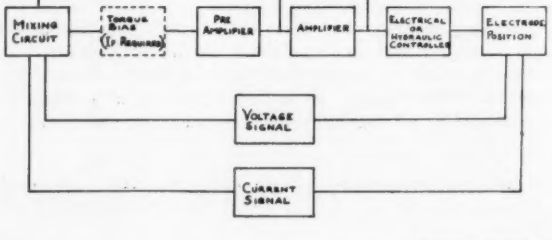
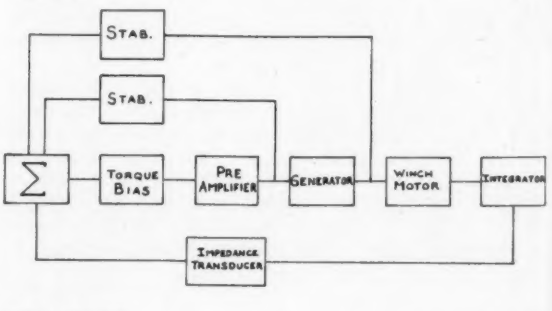


Fig. 4. Simplified system for electrical arc furnace regulator



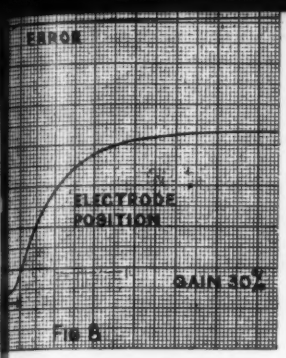


Fig 8

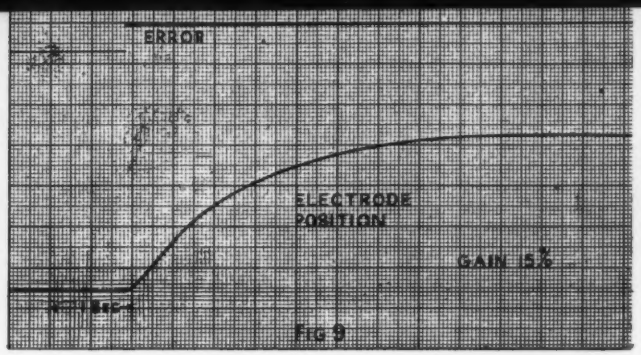


Fig 9

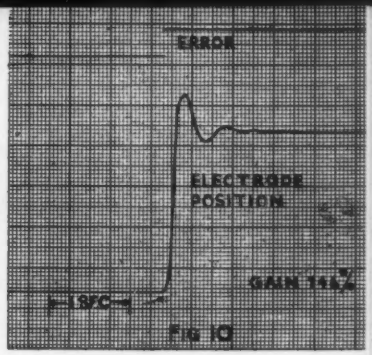


Fig 10

design are available.

In general, this type of regulator receives its control signals from voltage and current in the same manner as for the electrical system. These signals are fed to a pilot valve and any unbalance between them operates the valve to give either an "on-off" or proportional control to a main valve supplying a ram to which the electrode is attached.

Hydraulic regulators, due to the low inertia of the moving parts, can give very high rates of acceleration, theoretically leading to a very fast rate of response. In practice, however, hydraulic regulators have to operate well below their theoretical optimum acceleration. Due to the inherent overhang of the electrodes from the rams, the mechanical structure is far from rigid and high accelerations give rise to mechanical oscillations with the consequent danger of electrode breakage, carbon pick-up and current surges.

5. General Design Criteria for Regulators

To design any closed-loop control system for optimum performance it is necessary to know within practical limits the physical constants of the individual elements in the system.

5(*i*) *Inherent Non-linearities and Variables in the System*

Fig. 3 shows a block diagram of a typical arc furnace electrode position regulator, which may be used to illustrate the elements in both electrical and hydraulic control systems.

The system can be divided into three parts:

(a) the pre-amplifier and amplifier
(b) the controller
(c) the arc characteristic.

The first two elements can in general be designed to produce a near linear output for small error signals but as the signals increase, gain falls off and a saturation limit is reached, i.e., no more output can be obtained from the amplifiers or speed from the controller. Saturation thus sets a top limit to the performance of the system. Nevertheless, the input/output relationship of these elements can be fairly closely predicted. The signal fed to the amplifiers, which is determined by the electrode position error, is derived from the arc characteristic, i.e., change in current and voltage for a given change in arc length or electrode position. This characteristic depends so much on operating conditions that it is very difficult indeed to specify.

As discussed in section 2(*i*), during the breakdown period when maximum response is required the arc is very unstable and the characteristic far from linear. It is thus necessary to estimate the arc characteristics from experiments (usually conducted during refining conditions). For 60 ton furnaces it has been found that, depending on arc voltage and current setting, the ratio arc current/electrode movement may vary by a factor of 6, and the overall loop gain and sensitivity will be varied in that ratio.

5(*ii*) *Assumptions*

For the design of the electrode-regulator it is assumed:

(a) that the steady-state top speed of electrode movement is known so that adequate saturation limits can be allowed for;
(b) error signals from electrode position remain linear up to the value required to drive the system into saturation or top speed, at which point the system becomes an "open loop" servo;
(c) however great the error signal, the system must correct the error without causing any overshoot in position.

5(*iii*) *Value of Analogue Computer Studies*

Once the preliminary design has been carried out on the basis of the assumptions stated in 5(*ii*), it is desirable to set the system up on an analogue computer and to vary the non-linear elements from their assumed values. The effect of changing arc characteristics can be simulated as a change in system gain, and stabilising feed-back circuits can be designed to secure optimum performance over as wide a range as possible. Data can be obtained quickly in this manner which would be impossible to obtain under field conditions.

5(*iv*) *Typical Design*

The block diagram of an electrical regulator is shown in Fig. 4.

The system was set up on an analogue computer and the stabilising networks adjusted to give optimum performance at the estimated maximum loop gain likely to be encountered in practice. Recordings of electrode position response were then taken (Figs. 5-9) showing the effect of changes in loop gain which could occur during a typical melt. Fig. 10 shows the effect of increasing the loop gain beyond the optimum, giving rise to intolerable overshoot.

The response time of a closed-loop regulator can be described in several alternative ways and the particular criterion used should be fully understood before comparisons between one regulator and another are made.

For instance, the response time may be based on the assumption that the response is *represented* by a single exponential term, in which case the response time will be quoted as the time to reach 63% of its full value. In a system with several time constants the actual time to reach equivalence may be very much greater.

The time to reach 95% of equivalence may also be quoted. This figure, providing the overshoot is within the tolerance for the system, gives a more accurate figure for the user, whose main interest is the time in which the error is corrected.

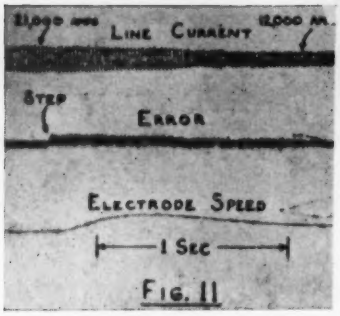


Fig. 11. Response measured by experiment

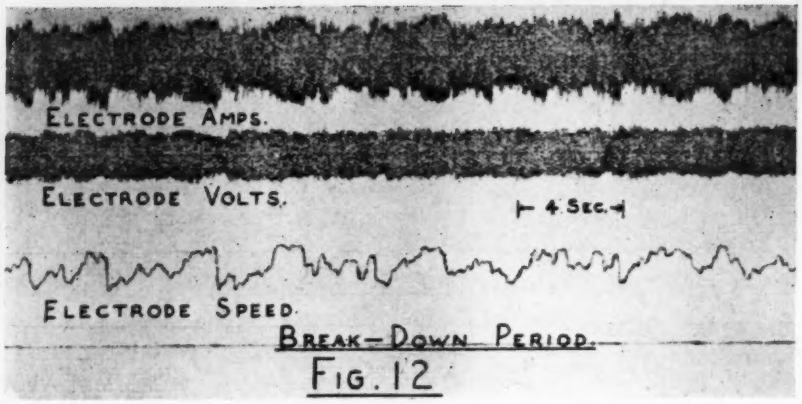


Fig. 12. Record showing electrode regulator performance during breaking down period

From Figs. 5-9 it can be seen that the time to reach 95% of equivalence varies from 0·2 sec at 100% gain to 6 sec at 15% gain, a gain ratio of approximately 6·5 : 1.

It is evident that in practice the arc characteristic plays a major part in determining the system response time and that in order to evaluate the performance of the servo system on an actual furnace, the arc characteristic should be known at the instant of test.

In practice this is impossible to determine accurately and can only be estimated from figures obtained at the same arc current and voltage measured during steady conditions, for instance during the refining period.

6. Results of Field Tests on Large Melting Furnaces

Tests on electrical electrode regulators have been carried out on a number of large furnaces to examine the correlation between theoretical and practical results. In addition an instrument was developed to analyse the surges in electrode currents both in amplitude and time.

6(*i*) *System Response*

The system described in 5(*iv*) was set up on a 60 ton furnace in accordance with the figures obtained from the analogue computer study. It was estimated from tests on similar furnaces that the maximum arc gain would be between 15,000 and 20,000 amp/inch of electrode movement.

In practice it was found that instability occurred during one phase of the breaking down period if the loop gain was set for a maximum arc gain of just less than 15,000 amp/inch. This indicated that the arc gain was slightly greater than 15,000 amp/inch during the breaking-down period. The loop gain was therefore adjusted to give overall stability. The response was then measured during the refining period, when the arc conditions were relatively stable. The electrode current was initially 21,000 amp and a step function calling for a change to 12,000 amp was injected into the system. The response was measured by recording electrode current and speed on a high-speed recorder with a response level up to 90 cycles per second, the time to reach equivalence being the time for the electrode to reach zero speed corresponding to final position. The results, shown in Fig. 11, gave a response time of 1·6 seconds.

The arc sensitivity was measured over the range 21,000 amp to 12,000 amp and found to be an average of 4,600 amp/inch. This represents a loop gain of approximately 31% (based on 15,000 amp/inch as 100%) and confirms, within experimental limits and the assumptions made, the response time predicted from the computer studies (2·1 sec at 30% gain; Fig. 7).

It is virtually impossible to obtain the maximum arc gain at any stable condition which would permit step function tests to be performed on the regulator. However, since the tests conducted at low arc gain confirm within experimental limits the results predicted from the analogue computer, it is to be expected at the maximum arc gain, which occurs during the breaking-down period, that the response time will be approximately 0·2 second as shown in Fig. 5. The only practical way to check the regulator for response, stability, etc., is to measure electrode current, volts and speed on a high-speed recorder. A typical recording is shown in Fig. 12.

6(*ii*) *Electrode Current Surge Analysis*

One of the most difficult features of arc furnace control is to determine a "Standard" for the control against which improvements can be measured. In general the process is so erratic that the results from oscillographic records, melting data, etc., must be obtained from a very large number of melts before it is certain that any adjustment represents an improvement or otherwise in the performance of the furnace. In order that this process might be speeded up, an instrument (shown in Fig. 17) was developed which would count and record surges in electrode current greater than a preset amplitude and duration, the instrument being read at specified intervals by the maintenance staff. The instrument was left in circuit at various settings for a period of fifty melts. The results of surge amplitude settings of 1·2, 1·5 and 1·75× full load current at 0·1 to 1·0 second duration for melts with 3 "baskets" of scrap are shown in Fig. 13. It was of interest to note that although the actual number of surges at a specified setting varied from melt to melt, the ratio between the number of surges (for various time settings) of different durations remained relatively constant and Fig. 14 shows the relation between surges recorded at settings of 0·1 second and surges of longer durations. Fig. 15 shows a typical record of the number

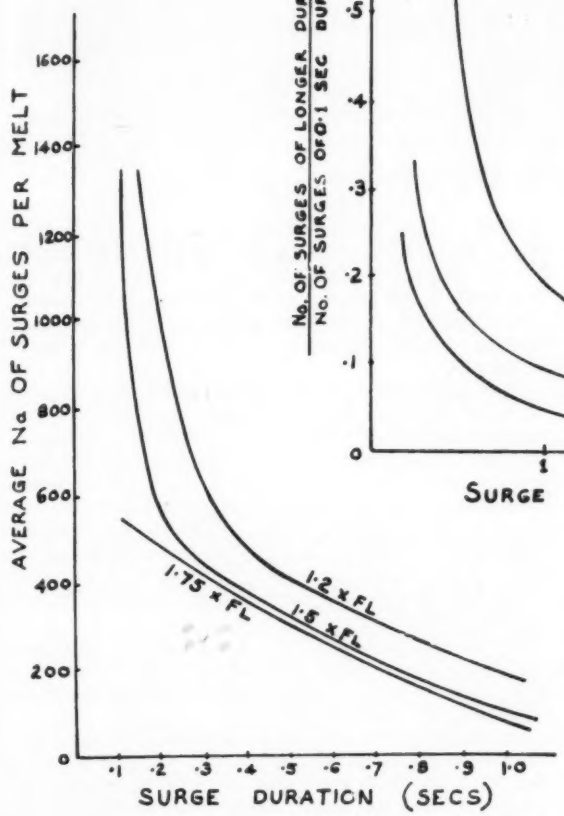


Fig. 13. *Surge analysis over* 50 *heats*

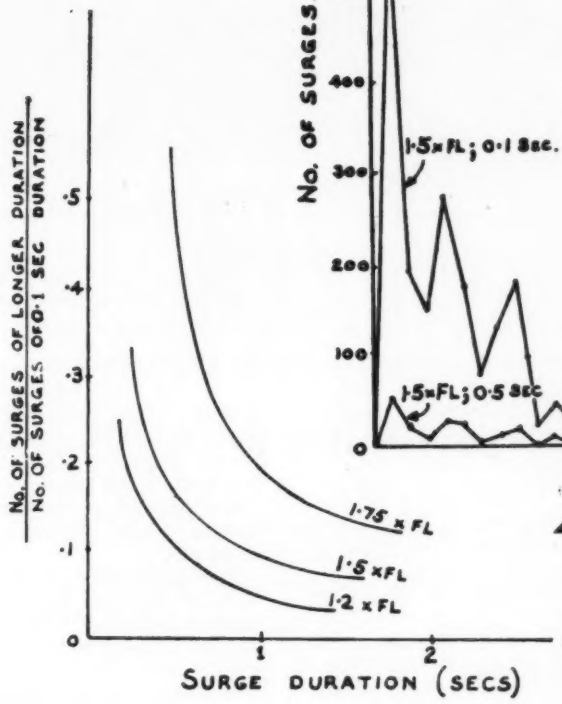


Fig. 14. *Surge analysis over* 50 *heats*

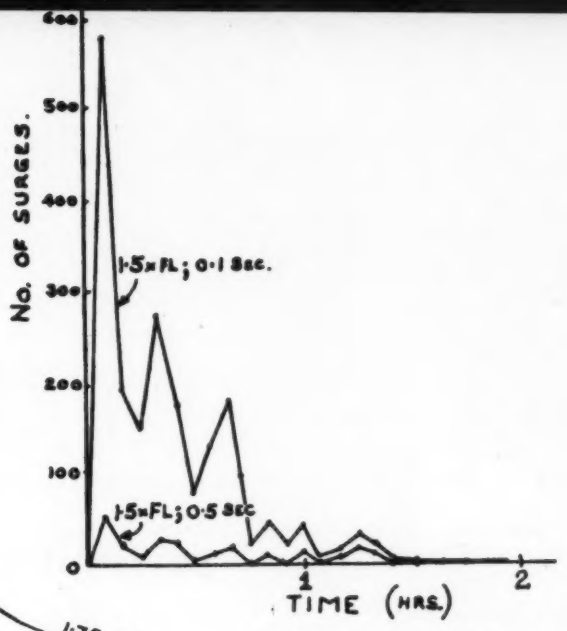


Fig. 15. *Number of surges occurring at* 5 *min. intervals during one melt*

of surges of 1·5 times full load current, lasting 0·1 and 0·5 second, which occur in 5 minute intervals during the melt down of one basket of scrap and early part of the refining period. The last few rises in the number of surges were due to the introduction of lime, etc.

From preliminary investigations it appears that altering the regulator gain produces an immediate change in the ratio between surges. Thus measurement of the ratio between surges may provide a quick means of evaluating changes in system performance. It should be appreciated that figures must be obtained from a large number of melts before accurate conclusions can be drawn and investigations are still proceeding.

6(*iii*) *Effect of Various Melting Conditions on Control System Performance*

Besides the current fluctuations which occur during the melting-down period, two further conditions can give rise to violent fluctuations. The first is when chemical compounds such as limestone, etc., are introduced during refining, and the second is a mechanical wave motion on the surface of the melt which can occur under certain conditions such as "boiling", etc. If the regulator is too slow and cannot follow the wave motion, carbon dipping or instability may result. The only remedy is to adjust the response to a value which enables the regulator to follow the wave motion.

It is of interest to note that magnetic stirrers do not appear to affect the performance of the regulator by creating excessive wave motion or by any other means.

7. Comparison Between Theoretical and Test Results

As shown above, the system response obtained from test under stable arc conditions agrees, within experimental error, with that predicted on the computer.

It has also been pointed out that, due to the unstable nature of the melt, the only way to estimate system response during the break-down period is to take actual dynamic recordings on a high speed recorder.

Even so, the performance may be affected by the sudden introduction of harmonics and rectification into the arc current and voltage caused by arc conditions. [4] A typical recording of part of the break-down period is shown in Fig. 16 where it is seen that rectification of arc current and voltage has taken place. Due to the regulator deriving its current signal from a current transformer (as did the recorder) the current signal is blocked and the regulator only receives the voltage signal. Thus under such conditions the resultant signal fed into the regulator does not accurately represent the arc conditions.

It must be emphasised that to draw accurate

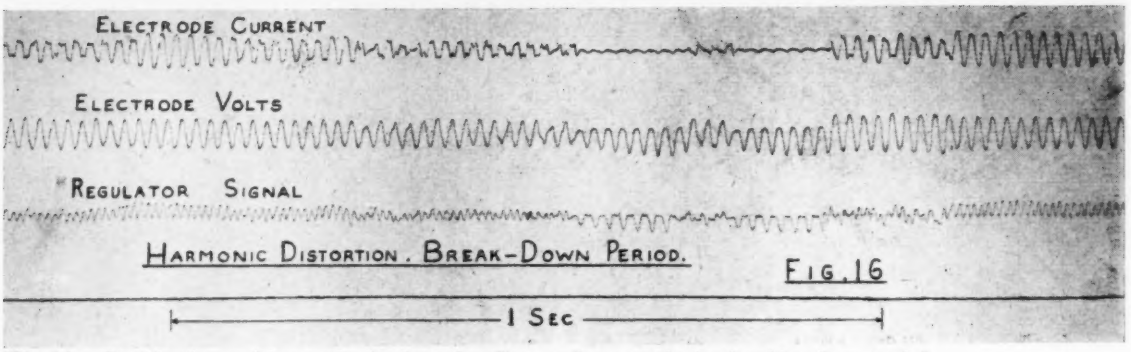


Fig. 16. *Rectification and harmonics in electrode voltage and current during breaking-down period*

comparisons for the response during break-down conditions a study should also be made of the wave-forms fed to the regulator.

8. Conclusions

It has long been recognised that the arc furnace is a difficult problem both for the control and supply engineer.

The design of efficient regulators is of the utmost importance in minimising system surges and increasing efficiency.

Electrode control systems are non-linear due to the fluctuating changes in arc gain which occur during the breaking-down period. With the use of system analysis and analogue computers a study of the effect of system non-linearities can be made over the estimated range of arc gain and the system designed for optimum performance. However, the arc characteristic is so unpredictable that more information must be obtained on arc behaviour before any further substantial advances can be made in electrode regulator design.

If electrode control systems are to be made more efficient by increasing the rate of response, very high accelerations of the electrode system will be necessary and the mechanical structure will have to be made very much more rigid in order to avoid mechanical oscillation. Recent investigations indicate that cyclic arc current variations may be due to magnetic and mechanical forces acting on the arc. It is possible that this form of arc instability may even be aggravated by fast acting regulators with response times within the natural frequency of the arc variations. Investigations into methods for increasing arc stability are proceeding and if satisfactory methods are evolved, the problems associated with electrode control will be greatly simplified.

Fig. 17. *Arc furnace surge analyser*

In evaluating the performance of electrode regulators on large furnaces under field conditions, care must be taken to use instruments with fast response. Maximum arc gain occurs during the unstable break-down period and it is impossible at this stage to check the operation by examining the regulator response to a step function change. The response must be obtained during the refining period and the arc sensitivity measured at the time of the test. Overall operation during break-down periods may be checked by measuring electrode current voltage and speed.

Due to the random nature of arc furnace loads from melt to melt it is often difficult to see immediately if any improvement has been made when changes to regulators are made on site.

An investigation into the surges occurring during an average melt has been made and from preliminary results it has been found that the ratio between surges of different durations are relatively constant from melt to melt and bear a relation to changes in electrode regulator performance, Measurement of this ratio may provide a method for rapidly evaluating improvements in operation when the correlation has become more clearly established.

9. Acknowledgments

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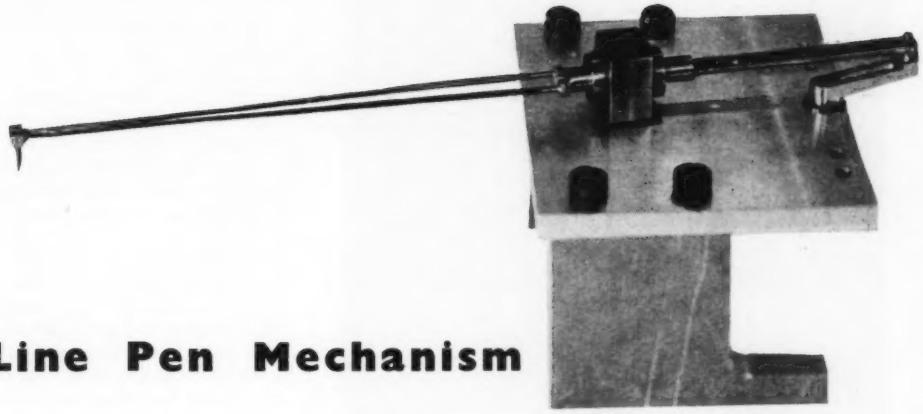
A New Straight Line Pen Mechanism



Model of new mechanism

By J. R. HALSALL, Dipl. El., A.M.I.E.E., A.M.Brit. I.R.E.

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A new mechanism for constraining a pen to move along a straight line, through a distance linearly proportional to the angular rotation of the input, is described.

The error in proportionality is less than 0·015% f.s.d. for an angular deflection of ±0·5 radians and the deviation from the straight line is negligibly small.

The mechanism is simple to make and considerably more accurate than the pen mechanisms used in present day chart recorders.

Introduction

PEN mechanisms used in chart recorders for data recording should ideally satisfy the following two important requirements:

(1) the pen should be constrained to move in a straight line across the chart

(2) the distance moved by the pen along the straight line should be linearly proportional to the input signal.*

Recorders equipped with mechanisms of this type provide true rectilinear recording with an evenly divided scale and are of great value for the study of transients and the measurement of amplitude and phase of periodic waveforms.

The input to the pen mechanism is provided by the driving system. Commonly, this may take the form of a bellows or piston operator for producing linear motion, or a galvanometer or similar device for producing rotary motion.

In the former case the main function of the pen mechanism is to reproduce to an enlarged scale the linear motion of the driving system. From theoretical considerations a pantograph linkage[1] is ideal for this purpose and this may be modified to provide additional constraints so that deviations from true straight line motion at the driving system will not be reproduced at the pen. The well-known Dobbie McInnes[1] and Thompson[1] engine indicators are familiar examples of this type of mechanism.

In the second case, where the driving system is a rotary device, the pen mechanism must provide accurate conversion of rotary to linear motion. Thus, in the numerically important case of the galvanometer recorder, the pen should move along a straight line through a distance proportional to the angular rotation of the galvanometer.

If straight line motion were the sole requirement this could readily be satisfied by the use of one of the many excellent classical linkages[2, 3] for constraining a point to move in a straight line which have been known for many years. A study of these mechanisms, most of which date from the period 1860-1880, reveals, however, that in none of them is the displacement of the point along the straight line linearly related to the angular rotation of any member.

Recording Techniques

Only two mechanisms used in recording instruments will carry out the conversion from linear to rotary motion exactly and neither are plane linkages. The

* These quite separate requirements are frequently confused when referred to under the common heading of "linearity". The terms "recti-linearity" or "true straight line motion" are preferred for requirement (1), departures from true straight line motion being referred to as "deviations". The terms "linearity" or "proportionality" should be reserved for requirement (2) departures from proportionality being referred to as "errors".

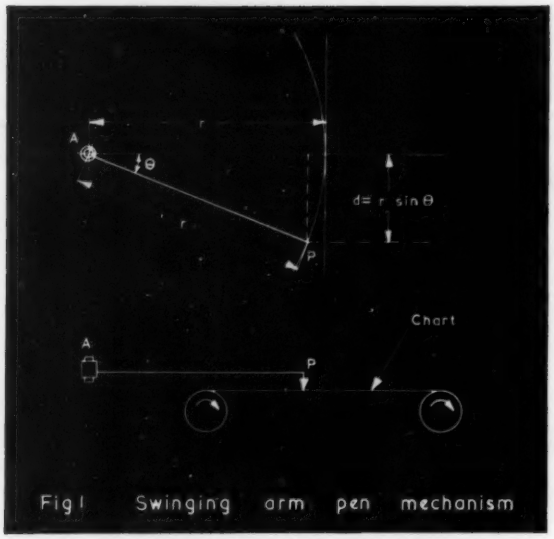


Fig 1 Swinging arm pen mechanism

first of these is the well-known cord drive and pulley system widely used in self-balancing recorders. The second is the half-turn helix and blade system which employs electrically sensitive paper and is used in the Muirhead "Mufax" system of picture telegraphy. In this system a potential is applied between the helix and the blade which are located on opposite sides of the special paper chart. Rotation of the helix causes the point of contact with the blade to travel linearly along the blade in a manner analogous to the operation of a lawn mower.

Whilst the cord drive system is very suitable for slow speed recording and the helix system for repetitive scanning, neither are entirely satisfactory for continuous high speed recording. The increasing demand for accurate rectilinear high speed data recording equipment in recent years has therefore stimulated the search for alternative devices for the conversion of rotary to linear motion and has led to a revival of interest in straight line mechanisms.

Modern developments in this field differ however from those of the nineteenth century kinematicians whose main objective was to avoid the use of slides which are bulky, subject to comparatively rapid wear and (in those days) difficult to manufacture. With the advent of improved manufacturing techniques it is now considered more important to devise a mechanism with the required characteristics than to avoid the use of slides and the slide is a feature of the recently-developed Massa Laboratories' high speed recorder[4] and the Texas Instruments' "Recti-Writer". Both of these instruments make use of linkages based on the mechanism for describing the conchoid of Nichomedes.[5, 6]

The new mechanism which is illustrated in Fig. 5 is also of the conchoid type and incorporates a sliding member. This mechanism constrains the pen to move in a straight line with high geometrical accuracy and accurately converts the angular rotation of the input shaft to linear displacement of the pen. The basis of this accuracy is best understood by considering the sources of error in the more elementary forms of direct writing galvanometers.

Elementary Mechanisms

In the simplest form of direct writing galvanometer the pen is rigidly attached to an extension arm and swings through a circular arc as the galvanometer rotates. The pen is normally in point contact with the chart as shown in Fig. 1, where A represents the galvanometer pivot, AP the extension arm of length r, P the pen and θ the angular deflection of the galvanometer from the mid-scale position. The displacement of the pen across the chart is given by:

$$d = r \sin \theta \quad \ldots\ldots\ldots (1)$$

and the pen deviates from true straight line motion by an amount equal to $r(1 - \cos \theta)$. The mechanism therefore has a sine-law characteristic.

An alternative arrangement which is sometimes used with heat sensitive paper is shown in Fig. 2. In this system the paper is drawn over a right angle platten and a long heated stylus is used. Marking takes place at the point of intersection of the stylus and platten which must always lie along the straight edge. The displacement of the pen across the chart is given by:

$$d = r \tan \theta \quad \ldots\ldots\ldots (2)$$

and the mechanism therefore has a tan-law characteristic. A mechanism having the ideal linear characteristic would yield an expression of the form:

$$d = r\theta \quad \ldots\ldots\ldots (3)$$

which differs considerably from equations (1) and (2).

Reduction of Errors

Expanding sin θ and tan θ in series form gives:

$$\sin \theta = \theta - \frac{\theta^3}{6} + \frac{\theta^5}{120} - \frac{\theta^7}{5040} + \ldots . \quad (4)$$

$$\tan \theta = \theta + \frac{\theta^3}{3} + \frac{2\theta^5}{15} + \frac{17\theta^7}{315} \quad \ldots (5)$$

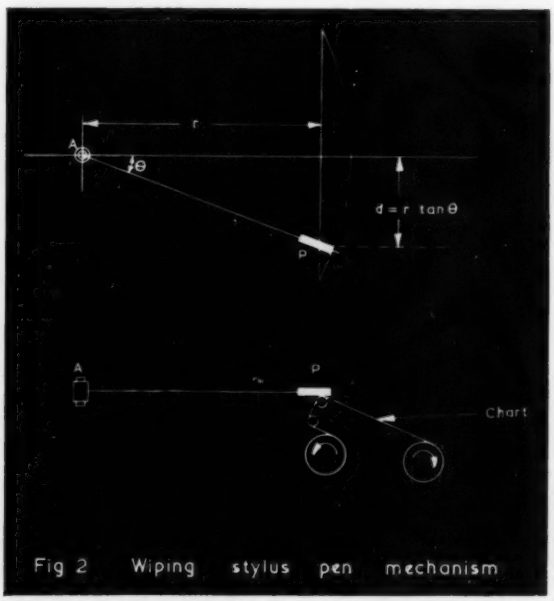


Fig 2 Wiping stylus pen mechanism

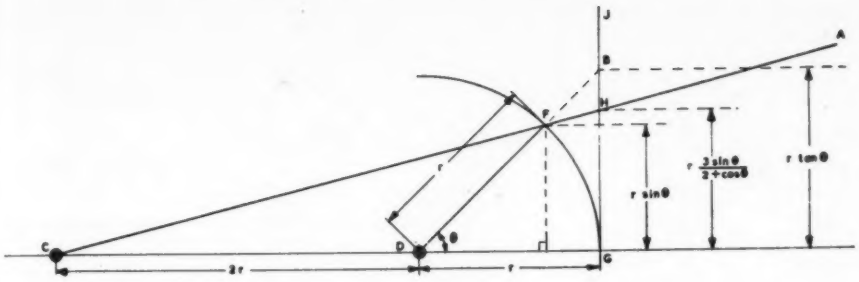


Fig 3 Geometry of intermediate law mechanism

from which it can be seen that the θ^3 error term of the tan-law mechanism is twice as great as that of the sine-law mechanism and opposite in sign. A close approach to the ideal relationship $d = r\theta$ can therefore be obtained by synthesising a mechanism with a law intermediate between sine and tan.[7]

For example the expression:

$$\frac{2\sin\theta + \tan\theta}{3} = \theta + \frac{\theta^5}{20} + \frac{\theta^7}{56} \quad \ldots\ldots\ldots (6)$$

is equal to θ to an accuracy of approximately 0·15% where θ is less than $\pm\frac{1}{2}$ radian.

An even closer approximation can be obtained from the geometrical construction shown in Fig. 3. This yields the expression:

$$\frac{3\sin\theta}{2+\cos\theta} = \theta - \frac{\theta^5}{180} + \ldots\ldots\ldots (7)$$

which is equal to θ to an accuracy better than 0·01% where θ is less than $\pm\frac{1}{2}$ radian. This expression is plotted in Fig. 4 for the range $0 < \theta < 1{\cdot}5$ radians.

Referring to Fig. 3, DF is a crank of length r, pivoted at D and making point contact with lever CA at F. Lever CA is pivoted at C which is at a distance 2r away from D and intersects the perpendicular GJ at H. The perpendicular distance GH is given by:

$$GH = r\left(\frac{3\sin\theta}{2+\cos\theta}\right) \simeq r\theta \quad \ldots\ldots (8)$$

The new mechanism in Fig. 5 incorporates the geometry of Fig. 3 in a practical straight line motion and provides the same degree of accuracy.

New Pen Mechanism

In Fig. 5, crank DF of length r is pivoted to frame at D and to lever EF at F. Lever EF of length 9r slides through bush C which is free to rotate. The pen is fixed to EF at E and moves in a straight line passing through O. Distance CD = 2r.

Since lever EF passes through bush C and E is assumed to lie on a straight line through O, every point on EF must describe a conchoid.[5] The locus of F must therefore satisfy the equation:

$$(x^2 + y^2)(b + x)^2 = a^2 x^2 \quad \ldots\ldots\ldots (9)$$

where

(x, y) are the co-ordinates of F with C as origin

a = length of EF

b = distance OC

But F is constrained to move in a circular arc by crank DF and must therefore satisfy the equation:

$$(x^2 + y^2) = r^2 + 2xc - c^2 \quad \ldots\ldots\ldots (10)$$

where

c = distance CD

Hence from (9) and (10)

$$\frac{a^2x^2}{(b+x)^2} = (x^2 + y^2) = r^2 + 2xc - c^2 \quad \ldots (11)$$

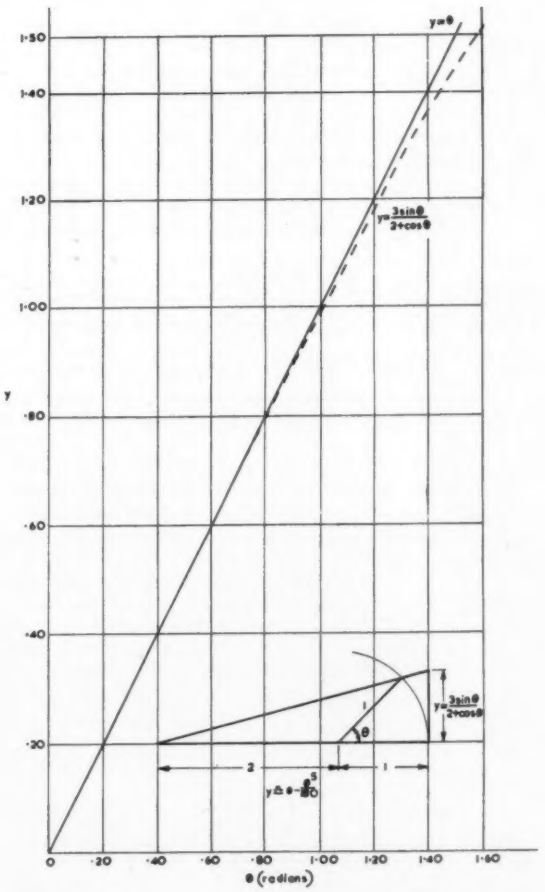


Fig 4 Plot of function $y = \frac{3\sin\theta}{2+\cos\theta}$

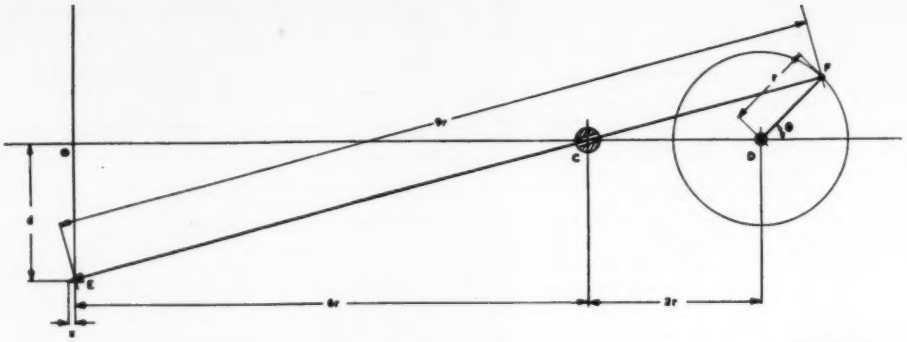


Fig 5 New pen mechanism

It can be shown that equation (11) can be satisfied to a very close approximation by setting $a = 9r$, $b = 6r$, and $c = 2r$, thus yielding the proportions used in Fig. 5.

From these values the following expression for the displacement of the pen from the mid-scale position is obtained:

$$d = r \sin\theta \left\{ \frac{9}{(5 + 4\cos\theta)^{\frac{1}{2}}} - 1 \right\} \simeq 2r\theta \quad \ldots . (12)$$

where

d = OE = displacement
θ = angular deflection of crank in radians

Also the deviation of the pen at E from exact straight line motion is found to be:

$$x = r \left[6 - (2 + \cos\theta) \left\{ \frac{9}{(5 + 4\cos\theta)^{\frac{1}{2}}} - 1 \right\} \right] \ldots (13)$$

where

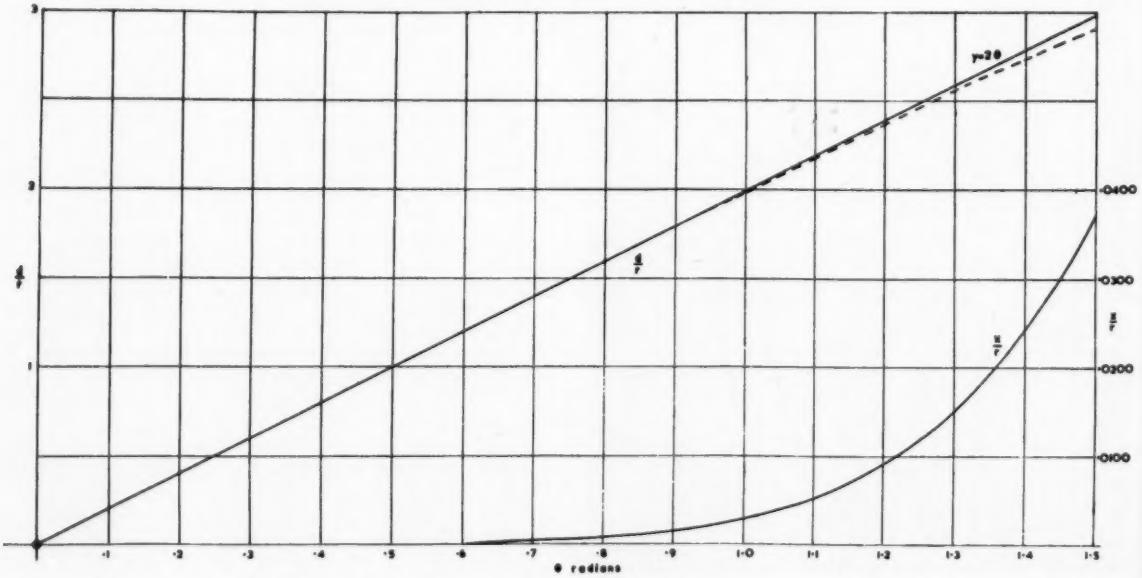
x = deviation.

Equations (12) and (13) are plotted in Fig. 6 and tabulated in Table 1 for the range $0 < \theta < 1{\cdot}5$ radians.

TABLE 1

θ (radians)	$\frac{d}{r}$	$\frac{x}{r}$
0	0·0000	0·0000
0·1	0·2000	0·0000
0·2	0·4000	0·0000
0·3	0·6000	0·0000
0·4	0·7999	0·0000
0·5	0·9997	0·0000
0·6	1·1991	0·0001
0·7	1·3981	0·0004
0·8	1·5963	0·0008
0·9	1·7933	0·0017
1·0	1·9885	0·0032
1·1	2·1814	0·0057
1·2	2·3710	0·0096
1·3	2·5563	0·0156
1·4	2·7359	0·0246
1·5	2·9084	0·0376

Fig 6 Linear and rectilinear characteristics of Fig 5



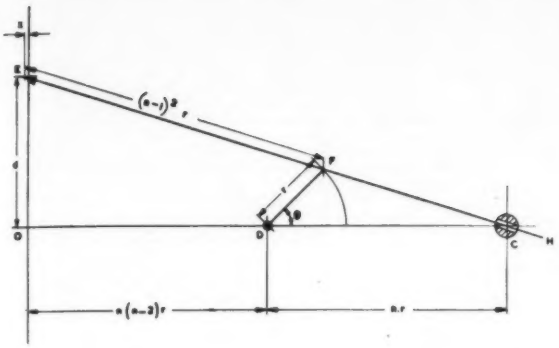


Fig 7 Existing conchoid type mechanism

For $\theta = \pm 1$ radian the error in linearity is approximately $\pm\frac{1}{2}\%$ of half scale, or $\pm\frac{1}{4}\%$ f.s.d. For $\theta = \pm\frac{1}{2}$ radian this error is reduced to approximately $\pm 0{\cdot}015\%$ f.s.d.

The deviation from exact straight line motion expressed in the dimensionless form x/r is approximately equal to 3/1,000 for $\theta = \pm 1$ radian and immeasurably small for $\theta = \pm\frac{1}{2}$ radian.

Comparative Performance

The basic mechanism from which the conchoid types of pen mechanism used in some present day recorders have been developed is described in Appendix 1 and illustrated in Fig. 7.

Comparing the characteristics of this type of mechanism with the new conchoid mechanism described here, it can be seen that the new mechanism provides a very marked reduction in linearity-error and deviation. This is shown for values of $\theta = \pm\frac{1}{2}$ and ± 1 radian in Table 2, which includes comparative figures for sine-law and tan-law mechanisms.

TABLE 2

	Linearity Error (% f.s.d.)		Deviation x/r	
	$\theta = \pm\frac{1}{2}$ radian	$\theta = \pm 1$ radian	$\theta = \pm\frac{1}{2}$ radian	$\theta = \pm 1$ radian
New Pen Mechanism Fig. (5)	0·015%	0·28%	<0·00001	0·003
Basic Conchoid Mechanism Fig. (7) (n = 6)	3%	12·5%	0·0075	0·120
Sine-Law Mechanism Fig. (1)	2%	8%	0·120	0·470
Tan-Law Mechanism Fig. (2)	5%	30%	—	—

Table 2 shows that for a given angular deflection the new mechanism is considerably more accurate than the other type listed. Accuracy of the other types can be improved by restricting the deflection to small angles, but to maintain the full scale deflection of the pen at a given value this will mean increasing the overall length of the mechanism.

Table 3 shows the comparative overall lengths in terms of f.s.d. of the various mechanisms and the angular deflections for an error in linearity not exceeding 0·25%.

TABLE 3

	Linearity Error less than $\pm\frac{1}{4}\%$ f.s.d.		
	θ max (radians)	Overall length	Deviation
New Pen Mechanism Fig. (5)	±0·99	2·25 x f.s.d.	0·00075 x f.s.d.
Basic Conchoid Mechanism Fig. (7) n = 3	±0·12	12·5 x f.s.d.	0·00004 x f.s.d.
n = 6	±0·14	21 x f.s.d.	0·00003 x f.s.d.
Sine-Law Mechanism Fig. (1)	±0·16	3·125 x f.s.d.	0·04000 x f.s.d.
Tan-Law Mechanism Fig. (2)	±0·13	4·0 x f.s.d.	—

The figures given in Table 3 show that in addition to being the most accurate mechanism for a given angular deflection, the new mechanism is also the most compact for a given accuracy and width of chart.

Inversions of New Mechanism

The new mechanism in the basic form illustrated in Fig. 5 is suitable only for use with a rotary driving system.

This basic mechanism may however be readily incorporated in various forms of pantograph linkage, in order to accept linear inputs. Examples of such inversions are shown in Figs. 8, 9 and 10, in which the linear inputs are reproduced at the pen to a scale of 1 : 8.

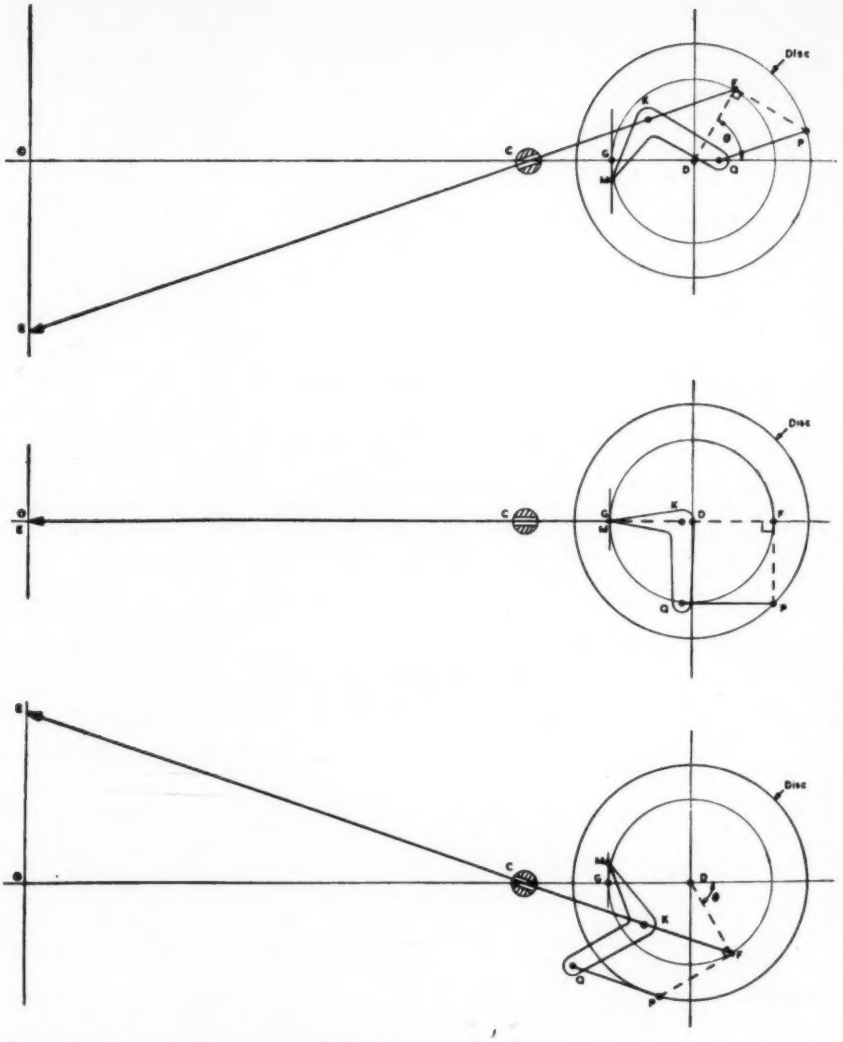
Many such inversions are theoretically possible. In practice it is necessary to ensure that none of the members are unduly short and that the parallelogram does not collapse and possibly cross within the range of the mechanism. The examples given in Figs. 8, 9 and 10 satisfy these requirements.

The addition of a reducing linkage does not affect the basic accuracy of rotary to linear conversion and both input facilities might conveniently be used simultaneously in a servo-operated recording instrument. Thus the reduced linear motion could be used to provide slide wire feedback and a rotary drive applied to the crank, or with a linear drive the crank could be used to provide rotary feedback.

Originality

In view of the attention which straight line linkages have received over a long period it would be unwise to assume that the new mechanism shown in Fig. 5 is entirely original. Subsequent to the development of this mechanism, a search of the literature was therefore made.

Fig 8 Variation of new mechanism (1)



Scale:

$R = 1$ in.

$\alpha = \frac{1}{8}$

$EF = 9R$

$OC = 6R$

$CD = 2R$

$DF = FP = KQ = R$

$MK = (1-\alpha)\,R$

$KF = PQ = \alpha 9R$

$\frac{GM}{OE} = \frac{1}{8}$

It was found that the production of straight line motion by mechanisms of this general form was not new [1, 8] but that the proportions developed here had not been previously suggested. A study of the mechanism shows that it can produce straight line motion with proportions entirely different from those used here, but that these particular proportions are the only ones which will provide for the displacement of the pen to be linearly proportional to the angular rotation of the crank.

The new mechanism is therefore unique in that it models the geometrical construction of Fig. 3 in a practical mechanism and provides accurate conversion of rotary to linear motion.

Acknowledgement

Acknowledgement is made to the Directors of Imperial Chemical Industries Ltd. for permission to publish this paper.

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APPENDIX 1

Existing Conchoid Type Pen Mechanisms

The basic conchoid linkage from which the mechanisms used

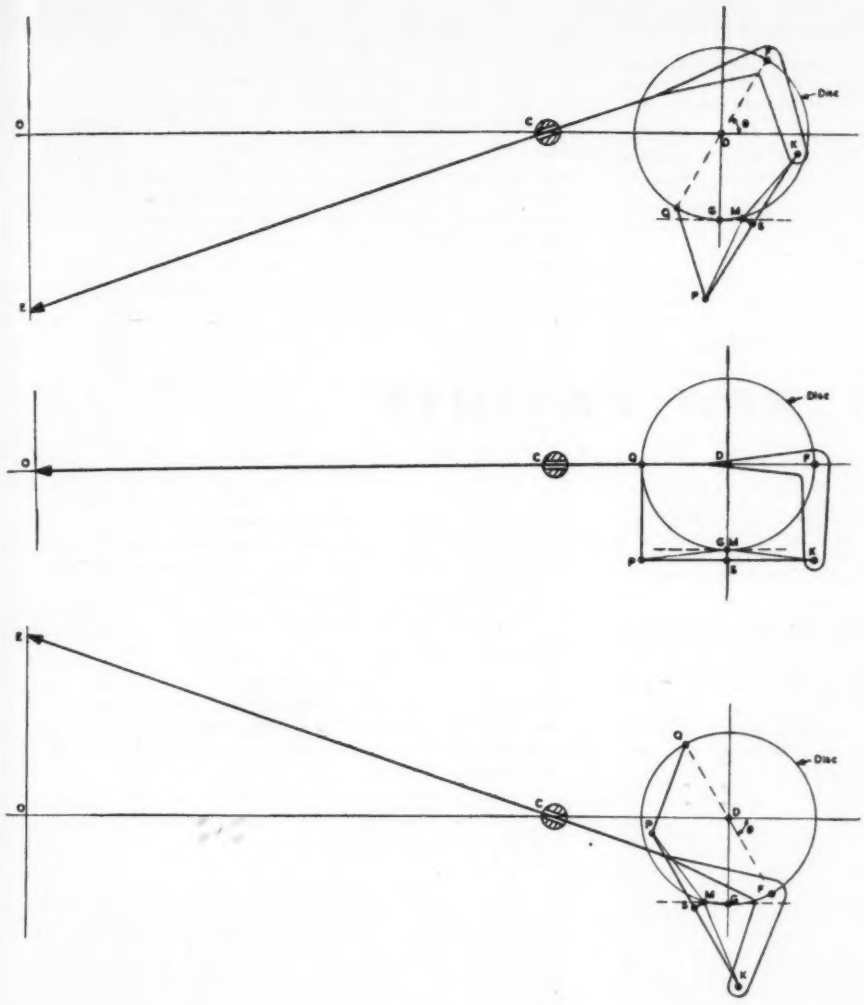


Fig 9 Variation of new mechanism (2)

Scale:

$R = 1$ in.

$\alpha = \frac{1}{8} = \frac{GM}{OE}$

$EF = 9R$

$DF = R$

$OC = 6R$

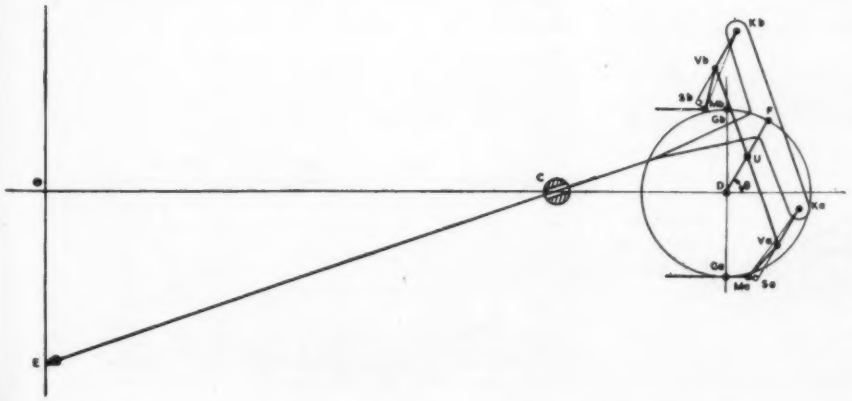
$CD = 2R$

$FK = QP = \alpha 9R$

$PS = KS = R$

$SM = \alpha R$

Fig 10 Variation of new mechanism (3)



Scale:

$R = 1$ in.

$\alpha = \frac{1}{8} = \frac{GM}{OE}$

$EF = 9R$

$DF = R$

$DU = \frac{1}{2}R = UF = VK = VS$

$SM = \alpha R$

$UV = FK = \alpha 9R$

in some existing recorders have been developed is illustrated in Fig. 7.

In Fig. 7, a crank DF is pivoted to frame at D and to lever EH at F. Lever EH, slides through bush C which is free to rotate, and carries the pen at E. The pen moves in a straight line passing through O.

The proportions given in Fig. 7 are chosen to provide cancellation of the θ^2 error term in the power series expansion relating d and θ. With these proportions d and x are given by:

$$d = (n-1)\,r\left(\theta - \frac{n+3}{6n}\theta^3 + \ldots\ldots\right) \quad \ldots\ldots (1A)$$

and $$x = r\,\frac{n(n-2)}{8(n-1)^3}\,\theta^4 \quad \ldots\ldots\ldots\ldots\ldots (2A)$$

Linearity is improved by increasing the value of n up to n = 6. Increasing n above this value has negligible effect.

For $\theta = \pm\frac{1}{2}$ radian and n = 6, the error in linearity is approximately 6% of half scale, or 3% f.s.d.

The deviation from exact straight line motion expressed in the form x/r is approximately equal to 7·5/1,000 for $\theta = \pm\frac{1}{2}$ radian. For $\theta = \pm 1$ radian the error in linearity increases to approximately 12·5% f.s.d. and the deviation x/r to approximately 120/1,000.

NEW PATENTS

The following extracts have been taken from specifications obtained from the Patent Office, and permission to publish has been given by H.M. Stationery Office. The Official Journal *Patents* can be obtained from the Patent Office, 25 Southampton Buildings, London, W.C.2.

Patent No. 798,670. Apparatus for De-coding Record Cards.

Metropolitan Vickers Electrical Co. Ltd. (*Inventor: David Pedley.*) *Application No.* 32881/53.

The information on the cards to be de-coded contains characteristic representations of quantities of, say, electricity, gas, etc., and can be in the form mentioned in the registering apparatus covered by Patent No. 756,663. The invention provides for a means of receiving the record card and a screen adapted to be viewed by the observer having markings of the values corresponding to the symbols recorded on the record card. These record card symbols may be piercings, punchings, indentations of the "Braille" type or markings by ink or carbon paper and their significance will depend on their position relative to datum points. The record card is illuminated by light controlled by the characteristic symbols on the card so that the light is projected for observation in juxtaposition to markings on the screen corresponding to the symbols on the card.

Patent No. 798,743. Flowmeters.

Elliott Brothers (*London*) *Ltd.* (*Inventor: P. D. Boyer.*) *Application No.* 22050/53.

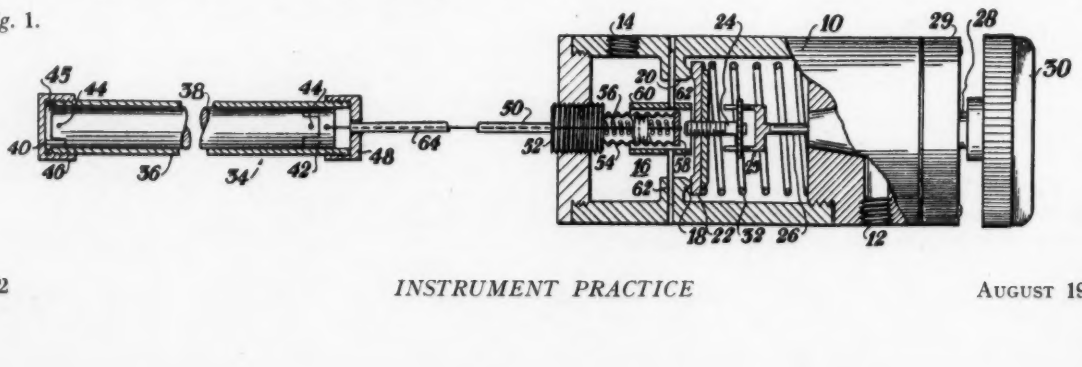
The invention relates to flowmeters and has for its main object the provision of improved dynamic flowmeters of high sensitivity, suitable for measuring low or high rates of flow, causing the minimum pressure loss in the flow of the fluid which is being measured. In this invention the flowmeter comprises a housing having a chamber with inlet and outlet passages for the fluid, and a curved deflecting means within the chamber exposed to the fluid issuing from the inlet passage as a jet. This deflecting means changes the direction of flow of the fluid and is displaced from its initial position under the influence of the fluid impinging thereon. Means are provided for constantly opposing such displacement and in detecting it to produce an output proportional to the magnitude thereof.

Patent No. 798, 842. Thermostatic Control Device.

Robertshaw-Fulton Controls Co. (*U.S.A.*) *Application No.* 36667/55.

This invention relates particularly to such devices for fluid fuel burning appliances for use in high temperature applications. It is the aim of the invention to provide an improvement on the rod and tube type device which is not satisfactory for high temperatures due to the direct rigid connection to the actuator. As shown in Fig. 1, the device includes a main casing (10) with an inlet (12) and an outlet (14) for fluid fuel. These communicate with a valve chamber (16) within which an annular valve seat (18) defines a valve port (20) for fuel to flow from (12) to (14). The valve member (22) is reciprocable into and out of engagement with the valve seat (18). The valve stem (24) has its further end connected by a suitable torque transmitting connection (25) to one end of an adjusting shaft (26), the other end of which is connected to the

Fig. 1.



operating shaft (28) supported by a cap (29) and carrying the usual adjustment dial (30). The valve (22) is biased towards the seat (18) by the compression spring (32). A thermal unit (34) comprising a metal tube (36) and a rod (38) made of materials having different coefficients of thermal expansion is indirectly connected to the valve (22). The length of the tube (36) can be adjusted by the screwed caps (46) and (48). The thermal unit is connected to the casing (10) by a flexible tube (50), one end being fixed in a bore in the adjustable cap (48) and the other held in the casing by being fixed within a bushing (52). A flexible bellows (54) is attached to the inner end of this bushing and has within it a spring (56) which biases the movable end (58) towards the valve stem (24). The end (58) is connected to the rod (38) by a flexible wire (64). The spring (56) maintains the wire (64) taut and should the temperature of the rod (38) and the tube (36) decrease, relative movement will occur between them causing movement of the rod (38) toward the casing (10). Should the temperature increase the tube (36) will expand and the rod (38) contract and will pull the wire (64) causing the movable end (58) to move toward the bushing (52) and allow closure of the valve member (22) under the bias of the spring (32). A modified construction is also specified.

Patent No. 798,917. Cyclic Memory System.

Underwood Corporation (U.S.A.) Application No. 25625/56.

This invention relates to data processors and more particularly to those having cyclic type memories such as magnetic drums, delay line registers and shift registers. It is claimed that the apparatus features processing data represented by electric signals comprising a data processing unit, a cyclic memory of the kind specified for storing data, a storage unit for storing data, means for recording data in and reproducing data from the cyclic memory and storage unit. Also means for transferring data from the cyclic memory to the data processing unit and thence via the storage unit back to the same position or positions occupied by the original data in the cyclic memory in less than one cycle of the cyclic memory. Other claims are made arising from or pertaining to this main claim.

Patent No. 799,078. Electrical Digital Computing Engines.

National Research Development Corporation. (Inventors: D. W. Davies and D. O. Clayden.) Application No. 6903/56.

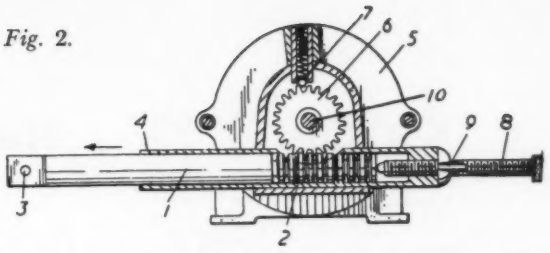
This invention claims to provide such a computing engine arranged to operate with an instruction word containing at least one address number, function digits and a timing number. Also arranged to use a modifying number for modifying the instruction word, including means for additively or subtractively combining the modifying number with the timing number, a store for storing at least part of the result of the combination of the modifying number and the timing number and means for modifying under control of a function digit, an address number with the content of the store.

Patent No. 799,149. Delay Action Mechanism.

Harold Ernest Ray Thomas. Application No. 264/56.

This invention is concerned with improvements in

Fig. 2.



the action of a delay action mechanism featured in Patent No. 613,328. As shown in Fig. 2, a main shaft (10) is rotatably mounted in the fixed case (5). In the case (not shown) is a gear wheel rotatably mounted on the main shaft adapted to be coupled to the shaft by a free-wheel. The gear wheel meshes with a train of gear wheels carried on stubs in the case, the last wheel of the train co-acting with an escapement rockably mounted in the case, or with an air vane. On the main shaft (10) is secured a toothed wheel (6) adapted to be actuated by a rack (1) formed of a rod having annular teeth (2) cut for a distance from one end of the rack, the other end having a hole (3) for attachment to the operating means. The rack (1) is slidably located in a tube (4) so that the rack teeth (2) can engage with the teeth of the main wheel (6). In the case is located a spring urged ball detention means (7) adapted to engage normally between the teeth of the wheel (6). An adjusting screw (8) with a locknut (9) is set for the amount of delayed action required. When the rack (1) is drawn in the direction of the arrow, its teeth in engagement with the main wheel (6) will rotate the main wheel and the shaft (10), which, through the free-wheel being locked, drives the train of gear wheels for the delayed action and finally the teeth (2) will pass out of engagement with the toothed wheel (6) to the end of the stroke to give the fast movement. This arrangement provides for the rack in co-action with the main toothed wheel (6) allowing of a slow or retarded action followed by a fast action in the direction of the forward stroke of the operating rack and, through the free-wheel, a quick return stroke in the reverse direction. This is claimed to be preferable to the means for braking and disengaging the rotatable members described in the parent specification.

Patent No. 799,514. Electronic Counting Devices.

Philips Electrical Industries Ltd. Application No. 33591/55.

The invention relates to such devices for use in electronic computers, operating preferably on the decimal system. In the device featured, trains of pulses are applied to a discharge tube and cause the discharge path therein to be displaced step by step from one stable position to the next so that the tube functions as a counting tube for counting the pulses. The tube is connected to a second tube functioning as a reading-out tube whose discharge path is displaced through a number of steps equal to the number stored in the counting tube in response to the necessary number of pulses. The reading out tube emits a pulse at each step taken by the discharge path and finally a pulse which causes the reading tube to become zero.

Resilient Buffing Wheels for Precision Potentiometers and Instruments

Part 1

Introduction

THE usefulness of a finished precision potentiometer as an electro-mechanical transducer is usually largely determined by the closeness with which it reproduces a required resistance or "resistance-ratio: contact-displacement" law and the confidence which can be placed in its retaining this law throughout its working life.

Factors which affect these requirements are:

(a) the dimensional accuracy of the former
(b) the ohmic resistance per turn of the winding when it is ready for use
(c) the finite resolution inherent in making contact with only whole turns or parts of turns
(d) the physical stability of the contact conditions including electrical, mechanical and thermal effects
(e) the wear of the contact track and of the moving contact.

Many present-day applications of precision potentiometers demand the best control which can be attained of all of these factors.

The method used to prepare the contact track on the winding can affect importantly the resistance per turn, the contact conditions and the wear of the track and moving contact. The effect of finite resolution is usually disturbing, so that the finest gauge resistance wires which can be produced and handled are now used to reduce it. Wires of 0·0005 in. diameter are available in suitable materials, and the need for further miniaturisation of components continually calls for finer gauges. Potentiometer "buffing" (i.e., the creation of a contact track by removal of any protective coating of the conductor) and cleaning windings made from such wires is a micro-grinding operation. Ideally this must be done without removing any of the material of the conductor or, alternatively, by removing it in a precisely known fashion. It must not damage the insulation between turns and it must not leave debris between the turns or embedded in the wire which can disturb the making of a reliable contact or harm the moving contact itself. Harsh abrasives such as emery can remove the conductor rapidly and, becoming embedded in the conductor or transferred to the moving contact, can severely limit the life of the finished potentiometer. A well-prepared contact track should have a high burnish before the potentiometer is put to use.

Methods of Buffing Potentiometers

The materials to be removed from the completed windings of conventional wirewound potentiometers in exposing the required contact track are wire enamels, baking varnishes, potting resins and metallic oxides, all in thin coats. These include oil, phenol, polyvinylacetal, polyester, silicone and epoxy resin-based enamels and nickel oxide.

Solvent methods of buffing cannot usually be employed because of the risk of damaging inter-turn insulation. Enamel wire coatings have been removed, in Germany, by wiping the winding with acetone on felt, followed by gold-plating of the exposed track but the methods of buffing in current general use are mechanical for all gauges of wire and most utilise abrasion. The following methods are in use or have been used in the United Kingdom, Western Europe and America:

(1) abrasion with flour emery paper or fine glass paper, by hand
(2) abrasion with flour emery paper followed with rouge on leather buff, by hand
(3) abrasion with rouge on leather buff, by hand
(4) abrasion with rouge followed by chalk on leather buff, by hand
(5) scraping with glass fibre scratch knot, by hand
(6) abrasion by motorised glass fibre wheel
(7) abrasion by motorised calico bob charged with Tripoli powder polishing soap
(8) abrasion by motorised felt bob charged with Tripoli powder or pure Al_2O_3

By K. F. SHRUBB, B.Sc.(Eng.), D.F.H., A.M.I.E.E., A.M.I.Mech.E.
(Elliott Brothers (London) Ltd.)

Making contour-following wheels to prepare contact tracks on wirewound potentiometers is described, using filled rubber or p.v.c. Insulation is removed from sides and tops of turns on all gauges of wire with high burnish and preservation of as-drawn wire contour. Abrasive and alloy hardnesses and melting points are correlated in discussing abrasive choice. Applications to polishing contoured instrument parts are described.

(9) abrasion by motorised Selvyt cloth buff charged with pure Al_2O_3
(10) abrasion with motorised clean felt bob
(11) abrasion by precision grinding, followed by gold-plating, polished with chalk by hand
(12) abrasion by honing
(13) abrasion by blasting with chalk
(14) abrasion by blasting with sodium bicarbonate
(15) machining with contour shaving machine.

Windings of wire of 0·010 in. diameter and larger have been buffed by methods 1, 2, 5, 6 and 7. Method 7 is unsuitable for wire below 0·010 in. diameter since grease from the polishing soap cannot easily be removed. Methods 4, 5 and 8 to 14 have been used on windings of the finest gauges of wire available.

Advantages and disadvantages of any method must be considered for each class of potentiometer and its production conditions.

Important factors are:

(a) amount of conductor material likely to be removed
(b) profile of completed contact track
(c) surface finish of individual wires in completed contact track
(d) nature and location of debris
(e) possibility of embedded material in winding
(f) consistency, speed and cost of method
(g) human skill required.

Where there is some expectation of the buffing method enabling inter-turn insulation to be removed below the level of the contact track, i.e., from the valleys between turns, the direction of cutting must always be along that of the individual conductor. This applies to all the methods except methods 11 and 12. In fact, however, methods 1 to 4 all effectively make a flat cut across the profile of the unbuffed winding, much like methods 11 and 12, and consequently they leave the inter-turn insulation substantially level with the surface of the exposed conductors. A radiused moving contact can then open-circuit as it rests on the inter-turn insulation and can pick up insulating material from it, while a turn-bridging flat contact can be partially supported on this insulation. Methods 5 to 10 can partially follow the contour of the individual conductor profile and thus potentially remove some of the inter-turn insulation. Methods 13, 14 and 15 can potentially follow the conductor profile closely but call for a highly developed technique to ensure reliable removal of the insulation.

Harsh abrasives of irregular particle size and shape like emery (natural Al_2O_3), glass and pumice are objectionable because of their irregular rate of cutting metal, the possibility of harmful embedded material and harmful debris which cannot be removed, and the poor surface finish imparted to the wire. Fine, regularly sized but hard abrasives like synthetic Al_2O_3 and optical grade rouge (e.g., SIRA rouge) are preferable to these but their rate of cutting metal is high and the debris is potentially harmful; the surface finish imparted improves as the particle size of the abrasive is reduced.

What is required of an abrasive method of buffing is that:

(a) it shall follow the contour of the conductor closely
(b) it shall use a fine particle size abrasive which cuts away the insulation but does not cut the conductor or become embedded in it
(c) it shall clean away its own debris
(d) it shall be straightforward and certain in operation.

The resilient buffing wheel method is a simple and satisfactory approach to this, applicable to all gauges of wire down to the finest available.

Resilient Buffing Wheels

The resilient buffing wheel is an abrasive wheel in which a chosen abrasive is included as a filler in a friable elastic bond which has no abrasive action by itself. It is used like a conventional grinding wheel but is distinct from it in having a contour-following instead of a contour-smoothing action.

It was developed for preparing the contact surfaces on precision instrument potentiometers so as to preserve the contour and surface of the as-drawn wire as nearly perfect as possible. It can follow the profile of a closewound helix wound in 0·0005 in. diameter wire and there is no indication that this is near the limit. It is simple to use and can be designed to have a large safety margin. It is simple and cheap to make so that a technique incorporating it can easily be evolved using low skill labour. It has been used in production since 1951 for buffing new and cleaning used precision potentiometers, and has come to be essential for attaining a required performance. It has other applications in instrument engineering.

Abrasive wheels having a soft elastic bond are not in themselves new. Dentists and dental mechanics use rubber-bonded pumice and rubber-bonded silicon carbide wheels; the latter have also been produced in large sizes for general workshop use. The purpose of the flexible bond in such instances is, however, to give a smoother finish in "cutting down" operations, the wheels being designed to have an enhanced contour-smoothing property.

Types of Resilient Buffing Wheels and Their Use

A resilient buffing wheel for potentiometer buffing is simply described as a disc of friable elastic bonding material with an abrasive uniformly dispersed in it which is harder than the insulation to be removed but softer than the metal of the conductor. Choices of bond are rubber and polyvinylchloride, preparing the latter being a simple do-it-yourself technique. The abrasive is simply a filler, i.e., it has no chemical reaction with the bond.

Wheels may be prepared in convenient sizes from, say, 6 in. diameter by $\frac{3}{4}$ in. thick, down to 3 in. diameter by $\frac{1}{16}$ in. thick, and are mounted on an approximately constant speed spindle revolving at about 2,000 revolutions per minute. The potentiometer to be buffed is held against the edge of the wheel, with the plane of the individual turns in the plane of the wheel, with enough pressure to dent the edge of the wheel a little. The abrasive in the wheel immediately begins to abrade the insulation to be removed. Within a few seconds the edge of the wheel begins to break away as a powdered swarf, much of which is thrown off by centrifugal force, and when this is happening the abrasion process is proceeding uniformly. Within a few more seconds the required contact track is exposed bright and highly burnished.

On examination, using at least a 50× microscope for fine gauge wire, it is seen that the valleys between the turns are buffed and burnished just as are the tops of the turns, and that the wire surface is exposed in apparently the as-drawn state since wire-drawing imperfections are visible. The profile of the buffed winding is seen to consist of circular sectors of the conductor joined by rounded-bottom valleys, on all wires down to 0·0005 in. diameter. The elastic bond has evidently yielded to the contour of the conductor and has presented the abrasive in such a way as to produce an even rate of cutting of the insulation over both the sides and top of the conductor. Provided the abrasive is not harder than the wire, it apparently does not cut the metal but leaves it with a high surface finish. (A reflected image of the laboratory window was seen under the microscope in a small diameter buffed wire.)

Debris from the wheel is left on the winding, including in the valleys. It is a dry powder consisting of particles of the wheel bonding material carrying the removed insulation, together with a fine dust of free abrasive possibly not wetted during the compounding of the wheel. This debris must be removed from the winding before it is put to use. A simple and reliable method is by brushing with an appropriately-sized bristle rotary brush. Liquid washing and air blast methods are not so satisfactory. The amount of debris deposited on the winding can be reduced a great deal by blowing it away with an air jet mounted alongside the wheel while buffing is proceeding.

The life of the wheel is limited only by its reduction in diameter. It wears away steadily but since it is very cheap to produce this is not usually important. As it reduces in size the peripheral speed becomes too small and its abrasion rate becomes unacceptably slow. Speeding up a small diameter wheel is not always satisfactory since the curvature of the wheel relative to that of the work affects its friability. A contact track having no curvature as on a slab type potentiometer is more difficult to finish conveniently than one which is convex in at least one direction for this reason. The best combination of wheel bond hardness, peripheral speed and radius of the wheel must then be sought but all the factors have a large tolerance.

The use of rubber-bonded resilient buffing wheels should be restricted to potentiometers which can be allowed to become appreciably heated locally during buffing. These are usually those wound with 0·010 in. diameter wire or larger. They should not be used on fine gauge potentiometers because of the inherent risk of adherent smeared rubber being deposited. Since rubber cannot usually be processed by the user, suitably filled commercial rubber compounds must be acquired to prepare the wheels. P.v.c.-bonded wheels can, however, be used on all sizes of potentiometer. They can be readily prepared by the user to his own specification.

Rubber-bonded Buffing Wheels

Pure gum rubber stock has no abrasive action on insulating resins, metallic oxides or metals. When applied to work as a grinding wheel it quickly softens and deposits a sticky smear which is difficult to remove when the work is either cold or hot. Common fillers for commercial rubber sheet are carbon black, whiting (ground natural chalk, $CaCO_3$) and materials of similar hardness. Carbon black has no abrasive action. Chalk, however, is well suited as an abrasive for resin type insulations and is the best general choice.

When certain grades of commercial rubber sheet are cut into discs and applied to metal work like a grinding wheel it is found that some adherent smears are at once deposited and this effect persists while the edge of the wheel warms up, the material never becoming freely friable. Other grades deposit smears when the wheel edge is cold but cease to do so when it is hot and then become freely friable, throwing off much powdered

rubber. A material of this latter type which has about 60 to 70 degrees Shore hardness and contains an appreciable amount of whiting or similar hardness compound as a filler can be used as a resilient buffing wheel for large gauge potentiometer wires.

Suitable grades of sheet, all inexpensive commercial grades, are:

Grade	*Manufacturer*
(a) Smooth black commercial sheeting, $\frac{1}{8}$ in. thick	James Lyne Hancock Ltd., London
(b) W.132, black, cold water quality, $\frac{1}{8}$ in. thick	Greengate and Irwell Rubber Co. Ltd., London
(c) W., black, cold water quality, $\frac{1}{8}$ in. thick	
(d) W.81, black, steam resisting quality, $\frac{1}{8}$ in. thick	

To make a buffing wheel suitable for potentiometers similar to or larger than a 10 in. potentiometric chart recorder slidewire wound with, say, 0·004 in. diameter enamelled manganin wire on a 10 in. long by 0·2 in. diameter aluminium straight former, proceed as follows. Cut four discs 6 in. diameter from $\frac{1}{8}$ in. thick sheet and sandwich them side by side between central metal cheeks $2\frac{1}{4}$ in. diameter, clamping all together with wire nails through holes in the cheeks. Bore a hole centrally. Mount the wheel on a polishing spindle of $\frac{1}{2}$ h.p. or more, rotating at between 1,000 and 2,000 revolutions per minute. Turn the wheel edge true with a hacksaw blade. To prepare the wheel for use, heat its rim appreciably by holding the edge of a piece of flat steel against it while it is rotating until it becomes friable.

While the edge is still warm, apply it to the unbuffed potentiometer. The wheel will buff at once. Press the work steadily against the wheel so as to maintain the temperature at its rim. If the temperature drops and a sticky smear is deposited on the work, warm the wheel again and remove the smear. The higher the pressure the higher is the burnish produced on the wire. The feel of the work against the wheel and the sound created by buffing are good guides to the uniformity of the buffing conditions. After buffing is complete, remove the swarf on the potentiometer with a rotating stiff bristle circular polishing brush having fine bristles, using only the tips of the bristles.

Such a buffing wheel is not suitable for removing the nickel oxide insulation provided on oxidised copper-nickel alloys and on oxy-insulated nickel-chromium and nickel-chromium-iron alloys or the normal oxide coating on oxidised nickel-chromium alloys since the abrasive is not hard enough. Material filled with considerably harder abrasive must be used and since there is no such rubber sheet commercially available, wheels must be specially made up with polyvinylchloride as the bond.

Polyvinylchloride-bonded Buffing Wheels

Polyvinylchloride (p.v.c.) is available as a dry powder which forms a paste when mixed at room temperature with a liquid plasticiser. When such a paste is held at a temperature of about 160°C for a time, depending on the bulk of the material, it gels completely and forms an elastic mass. The smaller the proportion of plasticiser in the paste the harder is the gel and its hardness can be varied in this way from spongy to fairly rigid. A large selection of fillers can be mixed into the paste without any chemical reaction. Since the equipment of the domestic kitchen is all that is required the user can readily prepare p.v.c.-bonded resilient buffing wheels to his own specification in this way. The technique is, however, well established commercially so that the work of preparing large batches can be contracted out.

Unfilled p.v.c. gel has no abrasive action on insulating varnishes and oxides. It is friable, however, until warmed sufficiently for it to begin to soften, a process occurring over an extended temperature range commencing somewhat below the gelling temperature. When applied to work as a grinding wheel and the wheel rim is much overheated, the p.v.c. becomes sticky and can deposit thin adherent streaks of material torn from the mass of the wheel. When subsequently rubbed, however, these streaks strip off cleanly and in this their adhesion is essentially different from that of rubber smears. With a suitably compounded wheel it is easy to prevent such softening occurring during buffing and even if it does occur any adherent streaks can be reliably removed by reapplying the wheel after a few seconds; the sound emitted during buffing clearly indicates when softening is occurring.

In preparing p.v.c. compounds for conventional use, special precautions are frequently taken including those against heat breakdown, light stability, porosity, inefficient use of plasticiser and poor dispersion of plasticiser and filler. None of these is of much concern for resilient buffing wheels, wheels prepared as described below having been satisfactory after storing for seven years. Thus it is not worth while adding a heat stabiliser to the formulation or to use a non-paste-forming resin as an addition, and insoluble lead and zinc compounds as fillers or present in brass moulds are allowable. Diluents to help in mixing should not be used since if they are not completely volatilised during gelling they can make the wheel material greasy. Simple steps to assist even dispersion and wetting of the filler in the mix should be taken, such as mixing the filler with the resin when both are in dry powder form or sifting the filler into the p.v.c. paste. Elementary steps to reduce entrapped air in the mix are also worth while since they reduce the porosity of the wheel; these are, taking care not to whip the paste, and either allowing it to stand for a day before gelling or extracting the air with a vacuum.

Factors affecting the contour-following abrasion process in buffing potentiometers are:

(a) relative hardness of abrasive, insulating coating to be removed, and resistance wire
(b) particle size and shape of abrasive
(c) Shore hardness of buffing wheel
(d) buffing pressure
(e) peripheral speed of wheel
(f) room temperature tensile strength of wheel
(g) softening temperature of wheel
(h) relative curvature of wheel and work.

The p.v.c. formulation should be chosen to have a suitable Shore hardness when filled and to have a high softening temperature and tensile strength. The last two properties are improved by using a resin with a high molecular weight and by a suitable choice of plasticiser. Dioctyl phthalate is superior to tritotyl (tricresyl) phosphate as a plasticiser for these reasons.

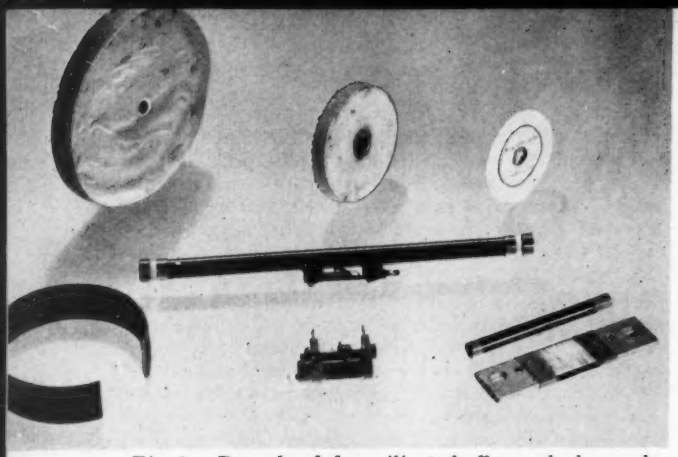


Fig. 1. *P.v.c.-bonded resilient buffing wheels, nylon brush and buffed potentiometers*

The compound is always used in its fully gelled state. With a chosen resin and plasticiser the Shore hardness of the gel depends on the proportion of plasticiser and the nature and proportion of the filler.

A p.v.c.-bonded resilient buffing wheel for general purposes can be made as follows, suitable for buffing potentiometers coated with any current insulating resin and made from any gauge of wire down to the smallest sizes available of resistance material of about 120 D.P.H. or harder; this includes 56/44 copper-nickel alloy (e.g., Eureka), many of the noble metal resistance alloys and the nickel-chromium alloys. A suitable size wheel for typical instrument pick-offs of say $\frac{3}{8}$ in. diameter or less and up to several inches long is one 3 in. diameter as cast and $\frac{1}{4}$ in. wide, used at 2,000 r.p.m.; such a wheel is usable until it is worn down to about $1\frac{1}{4}$ in. diameter. Larger work justifies a larger and thicker wheel to give longer life, the speed of rotation being reduced to keep the peripheral speed about the same.

The recommended formulation is:—
35% by weight Geon 121 paste-forming resin powder
35% by weight dioctyl phthalate
30% by weight precipitated chalk.
Precipitated chalk is specified rather than whiting (ground mineral chalk) since it is purer and has a finer, more uniform, particle size. The fully gelled wheel has about 65 degrees Shore hardness.

To make a small batch, mix the resin powder and the chalk well in the dry state. Add the dioctyl phthalate gradually and stir to make a uniform paste, trapping no more air than necessary. To obtain a well-compacted wheel allow the paste to stand for a day or extract the air from it with a vacuum. Pour the de-aerated paste into a thin metal open mould having the dimensions of the desired wheel; a tin lid is adequate. Place in an oven at 160±5°C. Hold at this temperature until the wheel is fully gelled, i.e., has a uniform tensile strength throughout its mass and is rubbery, not cheesy, in texture; a wheel 3 in. diameter by $\frac{1}{4}$ in. thick will be fully gelled in 15 minutes, one 6 in. diameter by $\frac{1}{2}$ in. thick in about 45 minutes. After cooling to room temperature the wheel is ready for use. The oven temperature must not be less than 150°C or development of maximum properties will never occur. Prolonged heating at any temperature above 150°C will ultimately cause the gel to harden as it decomposes with heat breakdown and this process is accelerated as the oven temperature is raised. The time safety margin is large.

Bore a central hole and fix the wheel to a 2,000 r.p.m. spindle; $\frac{1}{8}$ h.p. capacity is adequate for a 3 in. wheel. Hold a clean knife edge against the rim of the rotating wheel until it becomes friable and then turn the wheel concentric.

Hold the potentiometer to be buffed in both hands and apply it to the wheel rim with a small steady pressure so that the rim breaks up at a uniform rate into a fine powdered swarf. On fine gauge wires complete buffing will have occurred in a few seconds. Examine the surface of the buffed wire with a microscope (50× to 100× for fine wires), looking for the width of the enamel left between turns and for slivers of unbuffed enamel on the wire. If the enamel is not adequately removed increase the buffing pressure. When a suitable choice of buffing pressure has been made, buff the full contact track as desired. The sound created during buffing, and particularly the sound of the swarf thrown off against a metal sounding-board, and the feel of the work against the wheel are good guides to the uniformity of the buffing conditions.

The rim of the wheel should always be cleaned before each individual buffing operation. Buffing of precision potentiometers should always be done in a good light in an atmosphere completely free of abrasive grit and fibrous material (green baize on bench tops should be avoided) and preferably in quiet surroundings. The safety factors in the process are large since the possible buffing pressure is limited by the bending of the wheel, varying the thickness of the wheel being a useful control for this. If wheel rim softening occurs due to too high a buffing pressure and peripheral speed it is immediately clear from the sound of buffing. Should it occur, discontinue buffing, allow the wheel to cool for a few seconds and then rebuff areas which may have acquired adherent deposits.

Fig. 1 shows a number of p.v.c.-bonded resilient buffing wheels and potentiometers buffed with them.

Removing Swarf

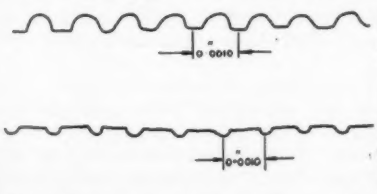
To prepare the potentiometer for use, the powdered swarf left from buffing must be removed. With a p.v.c.-bonded wheel this is mostly a powder having particles between 0·0025 in. and 0·005 in. diameter. It can be removed efficiently with a suitable rotary brush, one suitable for potentiometers closewound from 0·001 in. or larger diameter wire being shown in Fig. 1. This was made from 15 denier nylon monofilament 0·0018 in. diameter, assembled by hand by glueing tufts of filament between cardboard cheeks to

Fig. 2. *Profiles of potentiometer,* 0.0048 *in. diameter, enamelled copper closewound, buffed with p.v.c.-bonded chalk-filled wheel*
Before buffing *After buffing*

form a wheel $1\frac{1}{4}$ in. diameter and $\frac{1}{32}$ in. wide. The brush is rotated at about 1,000 r.p.m. and applied to the winding so that only the extreme tips of the filaments brush between the turns. Since the filaments were cut to length by hand many had been cut obliquely, producing pointed ends which can penetrate between turns of 0·001 in. pitch or less. The finest swarf and dust can be removed satisfactorily in this way as confirmed by the microscope. With even the lightest touch, however, a few minute particles of broken nylon can be left deposited on the winding. Nylon is far superior to any vegetable or animal fibre but the high tear strength of Terylene suggests it would be even better. A greater width than $\frac{1}{32}$ in. and smaller diameter filament would be other improvements. Rotary brushes made from long pile silk velvet or from a single disc of chamois leather (the rim fibres of which act as bristles) can be used but are not as efficient as the nylon brush; in particular with closewound windings not varnished after winding, fine pieces of silk or leather fibre torn from the brush can readily become trapped between turns. Superfine type circular wire brushes of 0·002 in. diameter steel or brass wires are unsatisfactory when used at speeds high enough to give efficient brushing since they can deposit broken pieces of wire on the work one or two bristle diameters long. A camel hair brush can be used by hand but is unreliable since it is difficult not to redeposit on the work some of the swarf removed.

Potentiometer Profiles

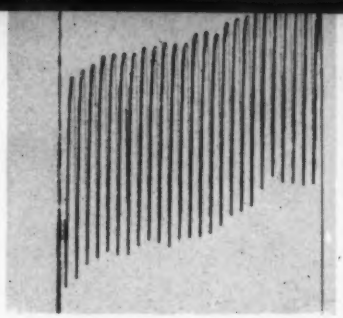
Fig. 2 shows photomicrographs of the profile of a potentiometer wound in 0·0048 in. diameter oil-base enamelled copper wire before and after buffing with a p.v.c.-bonded chalk-filled resilient buffing wheel. The potentiometer former was a thin card and the winding was closewound, unvarnished after winding and buffed along one edge. The preservation of the wire contour after buffing in spite of the softness of the wire material is clearly shown. Fig. 3(a) shows a tracing made by hand from the screen of a Vickers projection microscope operated at 360× magnification of the profile of a potentiometer wound in 0·0008 in. diameter bare nickel-chromium wire after similar buffing. The potentiometer former was a rod 0·2 in. diameter; the winding was spacewound at 0·001 in. pitch and coated with cured epoxy resin after winding. The contour-following abrasion process is again demonstrated. Fig. 3(b) shows a similar tracing of the profile of an identical potentiometer which had first been buffed by hand with rouge on a leather buffing stick and then rebuffed with a chalk-filled p.v.c. resilient buffing wheel. Before applying the wheel the profile at 360× was a



(*a*) *buffed with p.v.c.-bonded chalk-filled wheel*

(*b*) *buffed with rouge on stick, followed by p.v.c.-bonded chalk-filled wheel*

Fig. 3. Profiles of potentiometers, 0·0008 in. diameter resin coated nickel-chromium spacewound at 0·001 in. pitch



0·002 in. pitch, 0·00036 in. rise, Original 50× horizontally, 5,000 × vertically.

Fig. 4. Tomlinson recorder profile of potentiometer, 0·0016 in. diameter enamelled nickel-chromium close-wound, buffed with p.v.c.-bonded chalk-filled wheel

featureless straight line, i.e., the resin between turns was level with the exposed resistance wire. After applying the wheel it can be seen that the resin between turns had been abraded and the wire itself left untouched, so reducing the possibility of a contact wiper open-circuiting. Fig. 4 is a record of the profile of a potentiometer closewound from 0·0016 in. diameter enamelled nickel-chromium wire with 0·0019 in. pitch after buffing with a chalk-filled p.v.c. resilient wheel, taken with a Tomlinson surface profile recorder having a 90 degree V-shape diamond stylus with a tip radius of between 0·0001 in. and 0·0002 in. The contoured nature of the profile and its regularity are evident. The sharp bottoms on the record suggest that the V-shaped stylus may not have penetrated to the bottoms of the valleys while the regularly curved tops indicate that the stylus always traversed a well-curved path over the tops of the turns. The lightly loaded stylus scratched the wire to an unknown depth. The rise of the stylus shown is 0·00036 in., that is, nearly one quarter of the diameter of the bare wire.

Examining the contour of precision potentiometers made from wires under about 0·003 in. diameter is not easy. The difficulties are those of examining the profiles of fine screw threads on a much enhanced scale with the high burnish left on the wire by the resilient buffing wheel technique adding to them. It is difficult to set up a light transmission system for the usual projection technique which does not give a distorted, badly focused image, so that when comparing profiles of various potentiometers it is best to have the lighting and focusing conditions identical. The usual condenser illumination is unsatisfactory to obtain a true picture although reliable deductions can usually be made when using it. Truly parallel illumination appears to be a prerequisite, but it is then frequently difficult to obtain sufficient intensity. The Tolansky-Schmaltz light-profile technique[1] would be highly satisfactory for examining non-destructively and accurately the profiles of the finest gauge potentiometers. It consists of observing the shadow of hair lines projected obliquely on to the ribbed surface using a standard Vickers projection microscope or a metallurgical microscope with a modified internal reflector. A magnification of 400× would be adequate to show the highly burnished contour obtained on a fine gauge potentiometer with the resilient buffing wheel.

Reference

1. Surface profile measurement using the microscope. S. TOLANSKY, *Lab. Pract.*, **1** (1), Aug., 1952, pp. 193-196.

(*To be continued*)

Ferranti tape reader

Computers and the Electronic Office

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Part 4. Elimination of Input Errors—Management Statistics

NO computing system can produce more accurate results than the information which is fed into it, nevertheless, the design of many computing systems has paid insufficient attention to the problem of handling and dealing with original errors. Some of this lack of preparation has resulted from the overall planning being coloured by past experience with punched cards or keyboard machines, and though the rate of reading cards into a punched card installation might not be so very different from the rate at which they are read into a computing system, what happens to the information and the consequent repercussions are very different.

In the case of punched cards, the processing steps and the speed at which they are performed, after the reading-in stage, enables the operators to find and usually to correct differences and make all the necessary adjustments, without holding up the work unduly.

In a well-designed computing system, once the information has been read in, a relatively large number of steps are automatically performed at high speed. The result is that delay in tracing errors, which only become apparent at some but not all of the stages of processing within the computer, becomes extremely difficult.

Information read into a computer by means of punched cards is read in faster than by means of punched paper. Assuming that the cards are punched in nearly all columns, with present equipment the normal reading rate of 200 cards a minute of 80 column cards gives an effective rate of over 250 characters a second. It is very doubtful if the tape reading equipment marketed at present can in practice continuously average this speed.

Input Errors

The remarks that follow apply equally to cards and punched paper tape.

A normal operator punching cards from original documents will make an error rate of about 2% on the cards she punches. If the cards are verified this error rate will be reduced to something like 0·5% and the errors that still remain will have been caused by bad figures on original documents which had been misread by both punch and verifier operator.

If these cards are fed into a computing system, it will mean that one error enters the system about each minute, and this error will have to be traced back to source. With the computer carrying out several operations immediately following each other as part of its logical process, it soon becomes apparent that it will be very difficult to keep a system running smoothly unless extensive arrangements are made for tracing and adjusting these errors promptly.

Attempts can be made to write the computer programme in such a way that errors are thrown out as exceptions to be adjusted later, but in practice this could become an extremely unsatisfactory method, particularly when the computer totals have to be balanced with control totals, in some other part of the organisation.

It can be seen, therefore, that there is a good case for spending some time, money and effort to ensure that information is correct before it is read into the computer. One organisation has been so successful in this type of approach that their error rate has been reduced to something like one in 3,000 cards. This does not at present satisfy them, and they are seeking to improve upon it still further.

Reduction of Errors

What system shall be adopted to reduce these original errors, or catch them at source, will depend largely upon the type of application which is being carried out and the circumstances under which the whole operation is required to operate. One principle, however, stands out and that is that the amount of fresh information which is to be fed into the computer should be kept to a minimum and that the number of key depressions which have to be performed by an operator should also be reduced to an absolute minimum.

In designing a computing system, the capacities of the system are sometimes not fully appreciated and taken advantage of. Again this is because thinking is coloured by the previous requirements which were necessary to carry out the particular item of work under consideration.

It is perfectly possible for a computer to store on magnetic tape the static details relating to either a customer or an item of stock and this information can be of considerable length and capable of catering for a variety of circumstances. It can be referred to from the incoming data merely by means of a reference number and a code which will ensure that the system draws from its store that portion of the stored information which is relevant and required for the particular item of processing on hand.

The reference number can be designed in such a way that it becomes readily apparent to the computer if an error has occurred. There are a variety of ways of arranging check digits and reference numbers where the possibility of original error is reduced tremendously.

As an over simplification, therefore, if one were carrying out an invoicing procedure, all the keyboard operator would have to do would be to punch details of the reference number of the customer and the reference number of the stock item and the quantity. The computer could then very easily produce an invoice containing the full name and address, calculate the price of the particular item of stock, print its alphabetic description, apply the relevant discount applicable to that particular transaction, depending upon the discount worthiness of the customer, the quantity he had ordered and the particular item of stock. This discount calculation could be of a variable type depending on the circumstances for each and every stock item.

Not always would it be possible to establish such a procedure as this, because of the remainder of the requirements of the organisation of the computer user concerned.

Primarily he requires to despatch to his customer stock which is ordered. Once the goods are away he can then set about the producing of the relevant accounting documents. He, therefore, requires at a very early stage a despatch document and he is adding considerably to his clerical procedures if he produces a despatch document and then has to subsequently produce by means of another keyboard operation details to be fed into his computer, which may contain errors and consequently differ from the actual despatch documents themselves.

It is far preferable to be able to carry out both transactions by means of one operation, but obviously

Solartron ERA electronic reading automaton

unless he used the computer to produce the despatch documents themselves, and this would seldom be a practical proposition, it would be necessary for the operator to type in the name and address and alphabetic description of the goods, etc. In fact much more information is needed than merely account number, reference number, and quantity.

It is possible to arrange to type out this information on a despatch document. Then the equipment itself by means of form design and other features will reduce what is punched on the paper tape to an absolute minimum. This would result in possible errors in the alphabetic typing which, although not desirable, would not fundamentally upset the later processing of the work.

Part 3 of this series of articles mentioned that it was also possible, where the number of customers was relatively limited, to use edge punched cards to produce portions of this despatch document, i.e. name and address, etc.

This helps to ensure that the information is as correct as possible by reducing the number of key depressions which the operator has to make.

Under an ideal state of affairs, it could also be possible to read information into a computing system directly from original documents, but because in practice very few customers would be prepared to methodically carry out the instructions required on special order forms, this would result in so many exceptions as to make a system wholly unworkable.

Apart from automatic mark sensing operations, there are various photo scanning devices, which will read printed and typewritten characters. These items of equipment are usually rather expensive and the work with all its errors and troubles can usually be carried out more economically by means of keyboard operations.

Hitherto, the savings which have been incurred through installing computing systems for commercial work have on the whole tended to be rather disappointing, generally because the cost of the equipment and its installation has been underestimated or the savings overestimated. Also insufficient attention has been given to the requirements for 'backing up' personnel to deal with clerical tasks, which have to be

carried out before and after the computing operations proper.

As was indicated in the first part of this article, there is a great deal to be done to ensure that information fed into a computer is as acceptable and correct as possible.

Management Statistics

One of the other virtues of installing a computing system is the production of statistics and figures for management. Here achievements have proved to be better and companies have been able to profit extensively by obtaining quicker, more accurate and regular management reporting facilities at all levels. This has enabled them to take prompt remedial action to correct events which have not developed according to their original plans.

Again, however, there has to be fresh intelligent thinking in the planning stages. In some cases the management arrangement is such that it does not allow quick enough action to be taken on this information, because the delegation of authority has been built up on a pyramid type of basis. With computer information it is infinitely preferable to have more 'level' management, with delegated authority to take quick and effective action as and when this is required.

The type and frequency of the information which is provided is most important, and this cannot be laid down by hard and fast rules, but again will depend on circumstances.

A computer is capable of operating on management by exception techniques and will read and digest for management, and report only circumstances which management themselves require to ponder over.

Management will have to educate themselves so as to be able to instruct their senior executives what information they really will require. This is easier said than done, particularly when the people concerned are working under pressure with comparatively little time to sit back and think objectively. Here the consultant could probably help.

With a computing system, it will be possible to achieve and produce reports which have not hitherto been available. This again calls for radical re-thinking and in a great many cases it will require considerable revision of reference numbers, stock numbers and so on. This will often mean extra digits, which will enable the new information to be forthcoming at the stages at which it is required.

Anyone who has had the experience of revising reference numbers or re-coding categories will appreciate that this can be quite a task, particularly when it is necessary for two systems to be run in parallel over a period of time until the take-over has been completed. Fortunately, with a computer it is possible to have two reference numbers for the same item, for a period, and to arrange the computer programme in such a way that the machine will accept or deal with either number.

This and previous articles discussed what it is possible to do on a computing system. While it may be possible to carry out certain operations, it may not always be desirable to undertake the work for economic reasons, and the next article will consider some of the economic aspects of electronic computing systems.

TRACK RECORDING COACH

THE track recording coach ordered by British Railways as a result of their trials conducted some years ago has now been completed by Elliott Brothers (London) Ltd. It incorporates provision for assessing track conditions under a loaded vehicle while it is moving at speed over the track. The measurements are made in such a way as to make them independent of the movement of the vehicle. The techniques used were evolved after British Railways had undertaken tests of existing types of vehicles to compare their respective merits and suitability. Results of these tests indicated that none of these existing designs fully satisfied their stringent requirements in respect of accuracies, reliability and other features.

The new track recording coach was designed to satisfy these requirements and incorporates the most recent developments in measurement, transmission and recording techniques. It will show where improvement in track condition is needed and assist in the economic utilisation of permanent way staff. In addition the study of the relationship between vehicle behaviour and track irregularities, now receiving so much attention, will be facilitated by the provision of accurate data on the profile of the loaded track.

The coach is a 4-wheeled self-propelled vehicle capable of being driven at either end. It can travel at any speed up to 30 m.p.h. when recording and is capable of speeds of 55 m.p.h. when not recording. It is completely self-contained in respect of power supplies for instrumentation and other purposes such as lighting and heating.

For the measurement of cant (superelevation) a datum is provided by a high-speed gyroscope which enables the vehicle to operate accurately at any speed within the limits given above, regardless of curvature or gradient.

Curvature and gauge are obtained by measuring the movements of a system of probes which contact the inside edge of the head of the rail. These probes are designed to negotiate track fittings at the maximum recording speed. Provision is made to lift them clear of the rails when the car is not making a recording run or if any obstruction on the track makes it necessary.

Measurements are presented as traces on Kodak photosensitive paper in the multi-channel recorder which employs reflector-type galvanometers. The special paper used gives a record which is immediately visible and requires no further treatment unless additional copies are required.

At the same time as the record is being made a previous chart, taken over the same piece of track, can be viewed on an adjacent display. This comparison enables any deterioration to be seen immediately. Any maintenance work carried out since the previous run can also be checked.

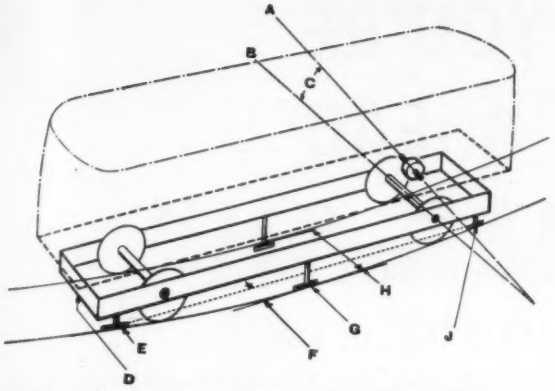


Fig. 1. Measurements of the curvature of the track

A. *Gyro spin axis (horizontal datum)*
B. *Axle*
C. *Cant*
D. *Probe carrying frame*
E. *Sensing shoe*
F. *Versine measurement of curvature*
G. *Sensing shoe*
H. *Gauge*
J. *Sensing shoe*

Measuring Apparatus

The positions of the equipment provided for the measurement of curvature, cant and gauge are shown in diagrammatic form in Fig. 1.

For the measurement of gauge and curvature, the probes are carried from a lattice girder framework supported at the axle boxes. So that the axles may follow the track without restraint, the points of support of this framework are arranged to give the necessary degrees of freedom permitting the axles to twist relatively in both vertical and lateral planes. In addition, "break-out" springs limit the shock which the framework receives when the wheels are subjected to severe vertical acceleration. The sensing probes are spring loaded against the rails and special guide shoes, running in the opposite flange way, ensure their passage through gaps at points and other fittings. At the actual opening in a crossing this guide shoe comes against the opposite check rail and prevents the sensing shoe from taking the wrong route (Fig. 2). Due to its small size the probe is an extremely sensitive detecting element of low inertia giving immediate and accurate response to any deviation from line or gauge. (This patented Elliott system obviates the need for a long probe otherwise required to span the gaps at points and crossings.)

When operating, the probes are held down by compressed air and can be withdrawn, clear of the track, when not in use. Raising and lowering is controlled through solenoid-operated valves. There is also a special emergency switch which enables the probes to be retracted by the observer if obstructions are seen on the track. Without stopping the vehicle, the probes can be lowered again on any piece of straight or curved track clear of points or other track fittings. The rubbing face of the probe consists of a welded deposit which can be renewed when required. At present the vehicle incorporates provision for measurement of curvature on one rail only. Irregularities on the other rail are deduced from the gauge record. Additional equipment to measure curvature on both rails can be added.

Cant is measured by comparing the position of one of the axles with a datum provided by the gyroscope mounted immediately above this axle. The spin axis of this gyroscope is maintained horizontal across the coach at all times. Correcting torques are applied to balance the effect of the earth's rotation and to allow for the movement of the vehicle around curves. (See Fig. 3.) The use of a gyroscope avoids the significant errors which can occur if a pendulum is used as a datum.

Fig. 2. Successive positions of sensing shoe in negotiating a crossing

A. *Sensing shoe approaching gap at crossing. Guide shoe has entered flangeway between opposite running rail and check rail*
B. *Guide shoe in contact with check rail prevents sensing shoe taking wrong route at gap*
C. *Sensing shoe has picked up again on the running rail before guide shoe leaves the check rail*
D. *Tie bar contains compression member for the negotiation of single bladed catch-points*

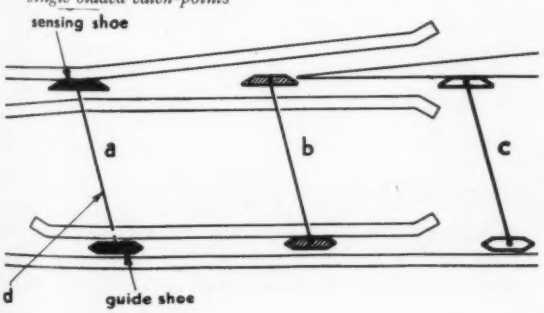
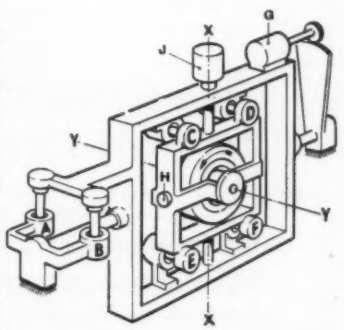


Fig. 3. Horizontal gyroscopic datum for cant measurement

A & B. *Torque motors to keep spin axis, Y-Y, across the vehicle*
C & D. *Torque motors compensate for centrifugal force on offset weight* (H)
E & F. *Torque motors correct for earth's rotation effect in plane of cant measurement*
G. *Pick off for angle between floor and spin axis* Y-Y (*angle between floor and axle added electrically*)
H. *Offset weight which precesses gyro until axis,* X-X, *is vertical*
J.A.C. *Pick off operates torque motors* (A & B)



Measurements of curvature, gauge and cant are obtained as a.c. signals from synchro type pick-offs. These signals are linearly demodulated and the resulting d.c. signals applied to high sensitivity mirror galvanometers. The record is produced by these galvanometers on a special photographic paper by the reflected beams from an ultra-violet light source.

In addition to the main measurements, the record includes the speed of the vehicle, distance marking, facilities to indicate events such as stations and space for making notes. The new record together with the "play-back" of a previous record are both fed through the recorder by a drive taken from one of the axle-boxes; a choice of scales is provided.

Circle 43 for further information

. . . *Yes!* YOU'RE YEARS AHEAD *with* SPEEDOMAX "H"

The compact instrument (11" x 12") at low cost

THIS line of indicators, recorders and controllers is unique—there is no comparable instrument available to you today. It is compact, all elements being readily accessible and all major components plug-in, and all moving parts operate by means of a common shaft driven by the positive worm gear of a high speed balancing motor. Limit of error is ±0·3% and balancing time 1 to 5 seconds.

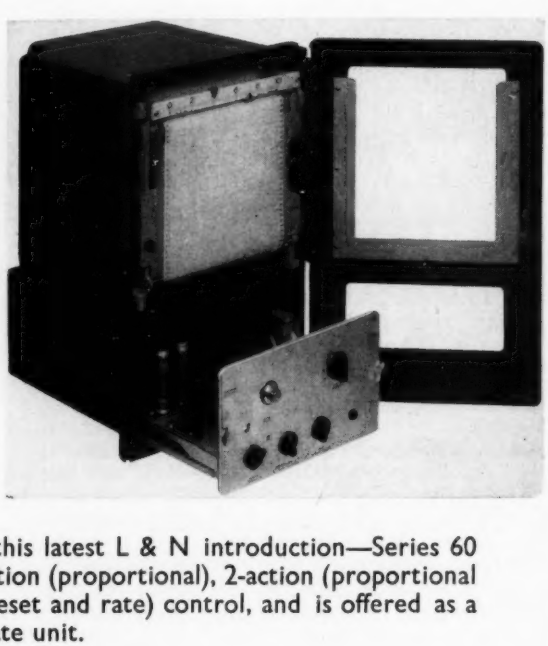
It is lower in cost than any comparable electronic potentiometer available today.

Speedomax "H" with Series 60 Control

Here is a completely new model of the Speedomax Type H potentiometer with additional controls now an integral part of the main instrument.

It is very compact, saving much panel space, being only $17\frac{5}{8}$" × 11" × 11".

The Control pulls out like a drawer.



Entirely new, and quite outstanding is this latest L & N introduction—Series 60 Electronic Control. It provides single-action (proportional), 2-action (proportional and reset) and 3-action (proportional, reset and rate) control, and is offered as a separate unit.

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2N561, 2N1014 Power Transistors

Two power transistors 2N561 and 2N1014 intended for use in heavy-duty industrial and military applications such as in power-switching, converter, voltage-regulator, and power-supply circuits, and as relay-actuating devices, are now available. These transistors may also be used in audio-frequency oscillator service, and in large-signal class A or in class B push-pull audio-frequency amplifier service.

The 2N561 and 2N1014 are of the germanium p-n-p alloy type. They feature a maximum peak collector current rating of −10 amperes and a maximum peak collector-to-base voltage rating of −80 and −100 V, respectively. The 2N1014 differs from the 2N561 in having higher maximum peak collector-to-base and collector-to-emitter voltage ratings for use particularly in those industrial and military applications requiring such high voltages.

In a typical common-emitter type of "on-off" power-switching circuit with a d.c. supply voltage of 28 volts and a driving power of only 42·6 milliwatts, these transistors can provide a power output of 54 watts with a power gain of 31·3 dB.

In a typical converter circuit with a d.c. supply voltage of 28 V and a d.c. supply current of 4·2 amperes, these transistors can provide a d.c. output voltage of 420 V with an efficiency of 88%.

The design of the 2N561 and 2N1014 utilises a special mount structure in which the collector is electrically and thermally connected to a mounting flange. This mounting arrangement provides for good electrical contact and excellent transfer of heat from the transistor junctions to the heat sink.

Circle **1** *for further details.*

Thermocouple Trip Amplifier

A FULLY-TRANSISTORISED thermocouple trip amplifier, Type N642, has been designed primarily for use in nuclear reactor installations, but it also has many industrial applications.

The type N642 monitors the temperature at a specific point within the plant and trips external guard circuits by releasing an internal relay when the temperature reaches the pre-set trip level. This level is set by means of a ten-turn helical potentiometer with a dial directly calibrated in temperature. A "low-margin" warning, also provided, releases a second internal relay and can be set at any point within the meter range, while the meter range can be supplied to order covering up to 100% of the ambient-to-trip-level range, with linear calibration.

Normally operated in conjunction with a chromel-alumel thermocouple, Type N642 can be used with other types with a slight modification. It covers the range 0-250°C and is fully "fail-safe" with an indefinite life expectancy. A trip will also occur with an open-circuit thermocouple. The range of the instrument can be extended up to 1,000°C to special order.

The amplifier requires an a.c. mains supply of 110 V-120 V or 200 V-250 V, 45-60 cycles (selected on a mains tapping panel). Four instruments can be installed side by side in a frame which fits a standard 19 in. rack.

A transistor chopper is incorporated in the input circuit, operating at approximately 700 c/s so that 50 c/s pick-up is rejected. This is followed by an amplifier and a detector which in turn releases the warning and trip circuits.

Circle **2** *for further details.*

Dewpoint Meter

A DEWPOINT meter developed in America is now being manufactured in this country under licence.

The meter, known as the Alnor Dewpointer, is portable and self contained, requires no coolant, and has a measuring range from −80°F to room temperature or from 0·0015% to about 2·75% water vapour by volume. The measurements are made by compressing a sample of the gas to a pressure at which, on suddenly releasing the pressure, a mist is formed, the temperature of the dew point then being calculated from the temperature and pressure ratio before expansion.

Alnor Dewpointer

The gas to be checked is drawn through the meter into an observation chamber with a hand pump, the chamber being fitted with a purging valve to allow a previous gas sample to be cleared. The chamber is illuminated to make the mist easily visible. The pump is designed to prevent the slightest trace of moisture being introduced into the chamber by the wiping action along its barrel. The meter is fitted with a sensitive thermometer mounted in clear Perspex and a pressure ratio gauge to give quick direct readings of the ratio of atmospheric pressure and observation chamber pressure. The meter can be battery operated or connected to the mains.

Circle **3** *for further details.*

Double and Triple Aquastat Controls

UNTIL recently boilers with high limit, low limit and circulator pump controls had to be fitted with two or three separate thermostats, each of which involved separate tappings in the boiler. The new range of insertion thermostats combine either two or three functions in one instrument.

The dual Aquastat consists of two fast-acting insertion controls, mounted in a single case, with two temperature setting adjustments independent of each other. Two hydraulic-action sensing elements are both housed in a single immersion well. The two direct acting micro switches mounted in the thermostat operate at any value between 100° and 240°F. A typical application would employ the combination controller as a low limit and high limit control all in one.

The triple Aquastat is similar but contains one single throw micro switch and one double throw micro switch which enables high limit control to be obtained on one switch and low limit and circulator control on the second switch.

The dual and triple function Aquastat controls will provide the boiler house engineer with a small compact control panel for all the limit functions of the boiler.

This range of controls can be applied to all types of oil and gas fired boilers.

Circle **4** *for further details.*

Circle 44 for further information

So simple!

So surely SIMPLIFIX the foolproof coupling!

Simplifix couplings form a perfect joint on almost any kind of tubing including those with very thin walls. All that is required is tightening with a spanner– no special work is required on the tube and the anti-friction washer prevents the tube twisting when the nut is tightened. Simplifix couplings are suitable for all pipe line systems up to 2" o.d. In a wide range of interchangeable standard fittings. Non-standard fittings of all kinds can also be made to order. Write for further information and fully illustrated catalogue.

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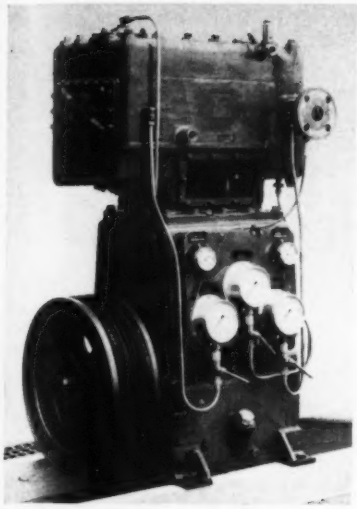


"Oil Free" compressor

"Oil Free" Compressor

A RECENT addition to the range of "Oil Free" air compressors is a 2 stage double-acting water-cooled model for pressures up to 250 p.s.i., whilst delivering up to 55 ft³/min of free air.

Primarily designed to Admiralty specification for supplying air to the servo-mechanism of the main control console and other instrument panels in the "Tribal" class frigates, it will shortly be in production for industry in general.

The pistons are of stainless steel and for ease of servicing are split to allow removal of rings. The piston rings are self-lubricating carbon running in hard chrome-plated cylinder bores. The valves are of the plate type, held in position by caps, enabling them to be assembled and replaced with ease.

The gland packing chamber has a large Perspex inspection cover to enable packing to be easily inspected and removed.

Lubrication of the crankcase is from a gear type pump driven direct from the end of the crankshaft. This section is divided from the compression chamber, ensuring that no oil, either in droplet or vapour form, comes into contact with the compressed air.

The method of unloading can be arranged to suit plants operating under manual or automatic control.

A pressure gauge board can be fitted as an optional extra and contains a 4 in. dial oil pressure gauge, 1st and 2nd stage air pressure gauges, a 2½ in. dial sump oil temperature gauge, and a 2nd stage air temperature gauge.

An interstage cooler is incorporated integrally in the cylinder head.

Circle **5** *for further details.*

Polypropylene Mouldings

POLYPROPYLENE mouldings are now available. Polypropylene is noted for its low density, high rigidity, retention of mechanical strength at high temperatures and excellent resistance to chemical attack.

The physical properties of polypropylene at 100°C are similar to those of standard polythene at room temperature. It will give good performance on repeated short term exposures up to 120°C. Above this temperature in the presence of ultra-violet light, oxidation proceeds progressively more rapidly.

At temperatures below 0°C the strength of polypropylene at very high straining rates is appreciably diminished and, whilst it may be flexed at temperatures well below 0°C without failure, its resistance to sudden shock at such temperatures is lessened.

Circle **6** *for further details.*

Stiff Mesh

THIS mesh, produced in roll or sheet form, similar to metal mesh, is made from Rigidex polyethylene supplied by British Resin Products and offers many distinct advantages. It has a very low specific gravity (0·96) and is thus only one third the weight of a corresponding aluminium mesh, and less than one eighth the weight of mild steel. In all thicknesses the mesh is flexible enough to be handled very easily, and in thicknesses above ¼ in. it is sufficiently stiff to be self-supporting.

The mesh has a comparatively high strength/weight ratio and is virtually indestructible. It is resistant to water, sea-water, practically all chemicals, and to most oils, greases and solvents. The inertness of the polyethylene from which it is made means that very few substances will adhere to it even temporarily, and the mesh is thus very easy to clean. In addition, the mesh is available in several colours which are inherent in the polyethylene, and it therefore requires no painting or finishing. The dielectric constant is 2·35 at 1 Mc/s and the power factor less than 0·0001 at 1 Mc/s. The mesh can be used at temperatures of up to 100°C without significant distortion and can thus be sterilised in boiling water if required.

Uses for the new mesh include guards for electric motors operating in corrosive conditions, battery separators, grilles and screens in chemical plants and laboratories, and filtration supports.

Circle **7** *for further details.*

Mason Neilan Air Filter Regulator

THE No. 77 Mason Neilan air filter regulator set comprises a large capacity dripwell, porous ceramic cartridge type filter, accurate pressure reducing valve and safety relief valve, all in one compact lightweight unit.

The rugged body is of die-cast aluminium with two mounting bolt holes. An outlet pressure gauge can be supplied fitted when necessary, and if necessary the outlet connection can be orientated in three alternative positions.

Elimination of alignment problems has resulted in a remarkably flat pressure/flow curve over a very wide range.

The No. 77 air filter regulator set can be supplied with or without outlet and/or inlet pressure gauges. The maximum inlet pressure is 250 p.s.i.; reducing pressure range is 5-40 p.s.i.; inlet and outlet connections screwed female; weight, 2¼ lb; and overall height, 8¾ in.

Circle **8** *for further details.*

Broadband Millivoltmeter

SPECIAL features of this instrument include its frequency range (2 c/s to 1 Mc/s) and its sensitivity (1 mV to 300 V f.s.d.). It has a low input capacity, high input resistance and is fully protected against overloads. Independent of mains voltage variations, it incorporates built-in calibrating voltages. There is also an additional switching position to overcome pointer vibrations at low frequencies. The broadband amplifier can be used separately.

In operation, the a.c. voltage to be measured is fed to a 6-stage amplifier, with attenuators in the first, second and fifth stages. This amplifier has a very high stability, due to negative feedback and stabilised supply voltages. The output voltage is rectified by a Graetz circuit with crystal diodes and is fed to a moving coil meter. As a result of the a.c. feedback, very good scale linearity is obtained. The instrument contains a stabilised RC generator with automatically-controlled output voltages of 30 mV and 10 V.

The GM 6012 is portable and is fully tropicalised.

Circle **9** *for further details.*

General-purpose Oscilloscope

THE TF 1330 is a general-purpose oscilloscope with all the features required for detailed viewing and measurement of waveforms. Its frequency response extends from d.c. to 15 Mc/s, and sensitivity is variable in seven steps from 50 mV/cm to 50 V/cm. A balanced lumped-constant delay line is incorporated in the vertical deflection system to allow distortion-free observation of the whole of a signal under investigation.

The time-base sweep velocity is variable from 1 sec/cm to 0·1 μsec/cm in 15 ranges, and can be increased up to 0·02 μsec/cm using X expansion; each range may be easily standardised against an external source. Triggering can be applied internally or externally, or from an internal supply-frequency source.

Directly calibrated potentiometers are used for the measurement of both signal amplitude and time: the calibration is

Oscilloscope, type TF 1330

accurate to within ±2% and is independent of either X expansion or Y gain.

The 5 inch cathode-ray tube has a spiral post-deflection accelerator and operates at an e.h.t. of 10 kV, features that combine to give a linear high-brilliance display at fast writing speeds or low pulse repetition rates. To allow full use to be made of the very slow time-base speeds, a longer persistence tube can be supplied in place of the normal type. The viewing hood around the screen of the tube may be removed to permit the attachment of a conventional oscilloscope camera unit.

A dual-trace model, Type TF 1331, is also available. This has the same basic performance as the TF 1330, plus electronic beam switching for displaying two signals either on alternate sweeps or at 100 kc/s switching rate.

Circle **10** *for further details.*

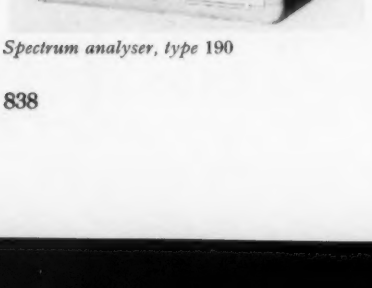
Spectrum Analyser Type 190

THIS instrument can be used at audio and supersonic frequencies to analyse the spectrum of a complex or simple signal. The frequency range of the standard instrument is from 500 c/s to 90 kc/s, but custom-built equipment for other frequency ranges is manufactured to order.

The analyser provides two alternative presentations of the spectrum. For rapid qualitative analysis, the spectrum is displayed on a cathode ray oscilloscope. The "X" co-ordinate of the trace represents the frequency scale and the "Y" co-ordinate the power level at any frequency. Accurate calibration of the frequency scale is made possible by imposing a marker "blip" on the trace derived from a calibrated manually-controlled oscillator.

In order to make an accurate analysis of the power distribution at any part of the spectrum, the marker blip is lined up on the point of interest and the analyser switched to "MANUAL" operation. The manual oscillator setting determines the centre frequency at which the measurement is made by means of a thermocouple milliammeter. The signal power level is determined by using an accurate calibrating oscillator, the meter indication always being set to a constant value by attenuator adjustment.

The power in a part of the spectrum can only be expressed with reference to the bandwidth in which this is measured, in this equipment 1 kc/s or 70 c/s.



Spectrum analyser, type 190

In addition to its function as a spectrum analyser at frequencies up to 90 kc/s, the instrument can also be employed for work at higher frequencies by the use of a suitable superheterodyne receiver in which the i.f. must have a minimum bandwidth of 100 kc/s.

Circle **11** *for further details.*

Kontak Metering Pumps

DIRECTLY controlled metering pumps for general chemical applications have been introduced with capacities from 0-1½ up to 180 gallons per hour.

The directly controlled metering head consists of a stainless steel or p.t.f.e. diaphragm unit, the volumetric displacement of which is adjustable by means of a hand-operated control knob, and a contact head—a body containing inlet and outlet valves—which carries all the parts coming into contact with the pumped medium. The ball type valves used in the contact head are in tandem so that slurry can be handled.

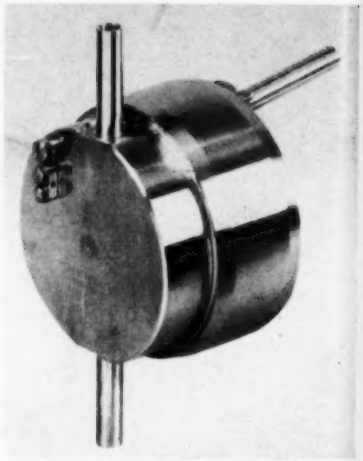
The reciprocating piston movement of the actuating pump is obtained by means of a circular cam with roller bearings. On a pressure stroke the metering head diaphragm is displaced to the limit of its travel and a surplus volume of oil is expelled through a relief valve to the oil reservoir.

On a suction stroke the diaphragm is displaced to the limit of its travel and then cavitation occurs in the pump cylinder. An inlet valve then opens to admit oil to the cylinder and this volume of oil is expelled at the next pressure stroke. In this way it is ensured that the diaphragm moves between fixed limits, which means that delivery is a function of diaphragm positioning and the speed of the oil pump only, and is therefore independent of installation conditions.

As the diaphragms are separated by a buffer chamber, the contents of this chamber determine the stroke of the diaphragm. The content can be varied by means of the hand-operated regulator. Although water is normally used as the diaphragm buffer liquid, silicone liquid may be used where high temperatures are likely to be encountered.

The actuating pump which provides the timed pulsating hydraulic drive, using vacuum oil as a medium, is connected to the metering head by means of a rigid pipe which may be branched to supply the drive to a number of metering heads.

The manufacturers claim an accuracy of less than ±2% within specified conditions and ±½% on repeatability under fixed conditions. Among other advantages claimed for the remote actuated pump are its ability to handle abrasive slurries and to run "stalled" indefinitely without damage, when operating against a blocked system. A complete hermetic seal between the pumped medium and ambient atmosphere, or actuating and control liquid, ensures freedom from contamination in either direction. Multiple installations may also be operated with independent control for proportionate mixing from one actuating pump. Unskilled personnel may easily demount and refit the contact head without stopping the actuating part. The pump, which is self-priming, not only handles highly corrosive and toxic materials, but also gives an appreciable suction lift and delivery pressure.



Kontak remote control metering head

Pumps with 2 ml and 15 ml per stroke displacement are available at present, but other types providing 5 litres a minute and up to 20 litres a minute are already under consideration. The 2 ml micropump has a maximum delivery pressure of approx. 750 p.s.i., and a maximum suction lift of 15 feet at 27 strokes/minute.

Circle **12** *for further details.*

Line Earth Loop Tester

A NEW instrument in the "Megger" series has been developed for line earth loop testing, i.e., testing of circuits which will carry current to earth in the event of a fault. With this instrument the full mains potential is applied to pass a current of approximately 20 amp through a circuit consisting of the live conductor, the earth continuity conductor and the earth return path, i.e., the instrument passes the test current through the actual fault path and the indicating instrument employed may be calibrated directly in terms of the resistance of this path.

A ballistic meter is used which will maintain the reading after the current pulse has declined. A synchronous motor, energised through a push-button switch, is used to drive a contactor which connects a 10 ohm resistor from the live conductor to earth for a period of 5 cycles (i.e., 0·1 second). The current during this period will be of a value determined by the 10 ohm resistor plus the actual resistance of the fault loop in series with the 10 ohm resistor. The meter, which is connected in parallel with the resistor, can thus be calibrated in terms of the loop.

The motor is automatically switched off when the current pulse has been passed, and the instrument embodies facilities for the resetting of the pointer of the ballistic meter after completion of the test.

Apart from the earth loop tests, the instrument can be used for determining the actual earthing efficiency of an electrical appliance. Jack plugs are fitted to the instrument which modify the test circuit in such a manner as to connect

the metal frame of the appliance and the attached earth conductor of the mains lead of the appliance, so that the resistance of the path may be measured. In this test, again the instrument imposes the same load conditions on the earthing circuit which might occur in the event of faulty insulation in any section of the appliance. Three-phase circuits may also be tested, a switch being provided for convenient switching from single to three phase.

Circle **13** *for further details.*

ASE Fully Automatic Scales

THE range of ASE fully automatic scales has now been widened to include larger capacity models for industrial purposes.

Shuttered indicators enable the pointer to make five revolutions of the dial to cover the instrument's full range, equivalent to a reading line of some 13 ft. The graduation divisions are about $\frac{1}{16}$ in. apart, and the scale can easily be read to half a division.

A quick tare device is available on all models, enabling containers weighing up to one-fifth of the instrument's total capacity to be tared instantly, simply by turning a knob. The fitting of this device increases the total scale capacity by one fifth.

Five basic models are available, A, B, C, CC and D, offering, between them, capacities of 2½ kg (5 lb) to 5,000 kg (1,000 lb).

Models A and B, covering capacities up to 30 kg (60 lb) are bench models, with front and rear dials, available with a variety of dial-centre heights and a choice of nine standard pan forms (the majority in anodised aluminium).

Models C and CC are also bench models with a single dial as standard. Front and rear dials, wheel-mounted base, and a tare beam or quick tare device are optional extras. They are available in capacities ranging from 20 kg (40 lb) to 200 kg (400 lb).

Model D is a floor scale with similar optional fittings to models C and CC. The platform is 900 × 700 mm (35½ × 27½ in.) with a rear wall 1,000 mm (39½ in.) high. Capacities: 100 kg (200 lb) to 500 kg (1,000 lb).

All models are available graduated in the metric system, in avoirdupois or any other system.

Prices range from £102 for the 2½ kg (5 lb) model A to £272 for the 500 kg (1,000 lb) model D.

Delivery is 4 to 8 weeks, dependent on model.

Circle **14** *for further details.*

Non-reset Electro-magnetic Counter

IN the design of this electric counter, the requirements of the manufacturers of coin-operated vending and amusement machines have been taken into account. This has resulted in the counters being tamper proof since the cover clinches through the base of the frame, and so cannot be removed without dismantling the counter.

The standard model is designed to be operated on 230 volts a.c. though other voltages can be catered for at slight extra cost.

Non-reset electro-magnetic counter

Delivery is 8/10 weeks, and the countesr sell for approximately 25s. 0d. each for quantities of 500.

Circle **15** *for further details.*

Elnik Controller

ON account of its switching without time delay and its high sensitivity, the Elnik controller is especially suited for processes with low transportation- and distance-velocity lag.

In conjunction with an electronic, delaying positive feedback, the controller is also applicable for solving more difficult problems. The feedback causes no permanent deviation at steady state condition. The controller can also be used with a thermal feedback.

Generally the controller is connected to one of the usual detecting elements, i.e., thermocouples resistance thermometers, resistance transmitters or measuring electrodes. Other detecting elements, supplying direct or alternating voltages, may be used, if necessary in conjunction with an electronic compensating amplifier or with a current- or voltage-transformer. The Elnik controller for two switching steps (ON—OFF controller) consists of the following main component parts:

measuring element with scale, set pointer and h.f.-sensing device,
amplifier with power pack,
switching relay.

The controller for three switching steps is equipped with two amplifiers and switching relays each with either one of two set pointers.

Circle **16** *for further details.*

Crimping Tool

THE crimping tool has no interchangeable dies and gives a four-point directional crimp for cables up to 7/0·064 in. diameter.

Standard 15, 20 and 40 amp Termalug cable shoes suitable for mounting on 4, 2 and 0 BA terminals can also be supplied.

With the crimping of copper ferrules it is suitable for floor warming heater cable jointing, resistance banks, and as insulated cover caps will shortly be available, they can be used on industrial and domesticinstallations.

Circle **17** *for further details.*

Crimping tool

Solenoid Valve for Heavy Fuel Oils

ALCON Type AOD/AC.30/4 Midget air-operated-diaphragm control valve suitable for use with heavy fuel oils. Size ½ in. B.S.P. or as required. The unit has been specifically designed to ensure positive on-off control of the heavier fuel oils, particularly when oils are not fully pre-heated. Operating diaphragms can be sized in order to utilise burner fan air pressure for actuation. Supplied complete with Midget solenoid-operated air pilot valve.

Circle **18** *for further details.*

Point Recorder Type NSQ

THIS miniature recorder has front frame dimensions 5¾ × 5¾ in., the chart speed can be varied between 5 and 1,200 mm/h and the printing speed between 30 and 1 second. Its applications include recording temperatures between 0 and 2,000°C, moisture content, liquid levels, conductivity values.

Recording of variables is effected by the chopper bar principle.

The chopper bar presses the pointer, playing freely over a scale, periodically on to the moving chart and thus on a colour roller underneath the chart. A point is recorded on the reverse side of the chart. This point is clearly visible in its exact colour through the transparent chart.

The pointer is then released to adjust itself on a new value. The recorded points form a curve.

The measuring point switch connects the following measuring point to the measuring element. Simultaneously the switching mechanism moves the respective colour roller forward into printing position. Thus curves of different colours are formed showing clearly the values of the variables even if these curves are close together or criss-cross.

Up to 6 measuring points can be connected to one multi-colour recorder. A multi-colour recorder for connection to 6 measuring points is easily changed to a recorder for connection to 3 measuring points, in that two terminal pairs are shorted and 2 × 3 rollers of the required colour are provided.

Circle **19** *for further details.*

Cold Box Installation

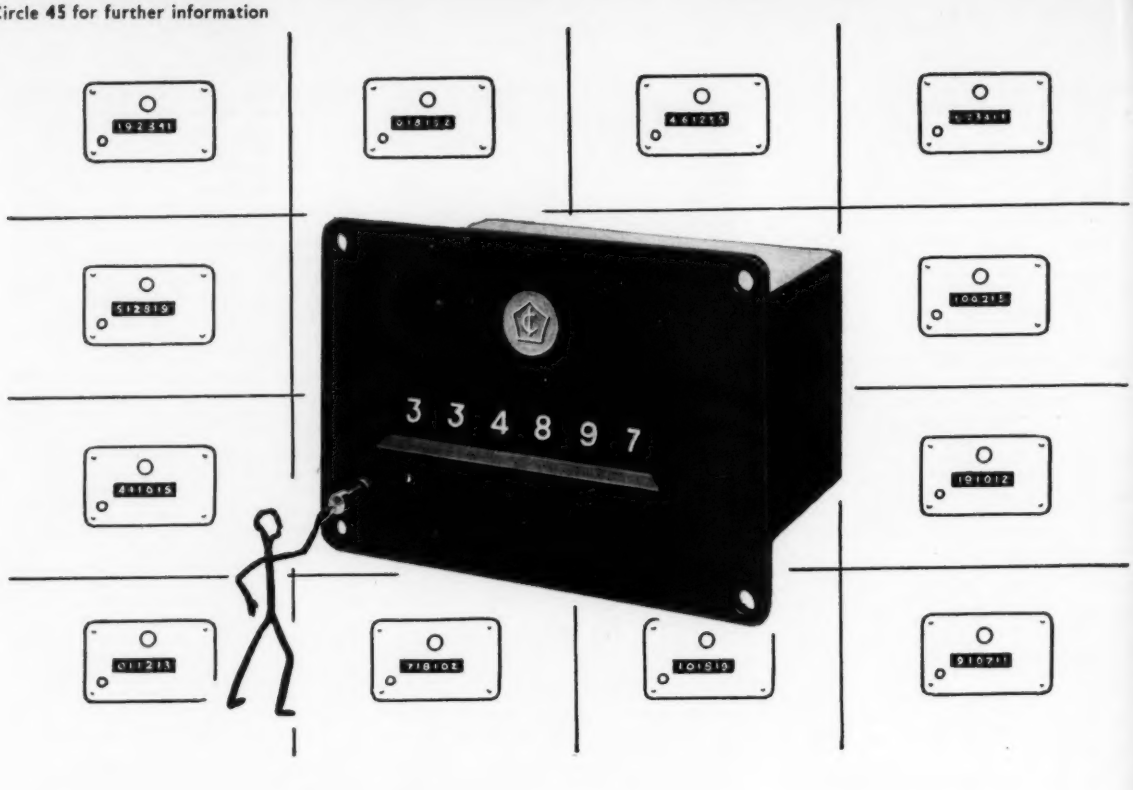
THE cold box installation has a net content of about 400 litres for temperatures down to − 160°C. Refrigerating capacity at −100°C is 4,400 B.t.u./h and 2,560 B.t.u./h at −160°C.

The cold box can be cooled at any preset temperature by the circulation of cold gaseous air. By means of an additional device, liquid air can also be produced.

A special head with an air circulating fan and driven by a built-in motor has been developed for the circulation of the cold gaseous air. The temperature control system consists of a resistance thermometer and a phase-sensitive relay unit. For the recording and automatic controlling of box temperature the following accessories are available:

1. Electronic temperature recorder, Type PR 2210/B/21.
2. Programme transmitter, Type PR 7211.
3. Multi-point potentiometer recorder, Type PR 3210B/00.

Circle 45 for further information



a ¢ NEW

HIGH-SPEED PANEL MOUNTING ELECTRO-MAGNETIC COUNTER

with PUSH-BUTTON RESET

All the well-tried features of our Type 100 Series Electric Counters are incorporated in this new model

plus—Sealing against dust.
plus—Large easily-read figures.
plus—Even longer life expectations at 25 counts per second.
plus—First wheel graduated 0 to 11 as optional standard.

Write for full details.

Counting Instruments Ltd

A similar counter with electric reset is also available. Details on request.

COUNTING INSTRUMENTS LTD., 5 Elstree Way, Boreham Wood, Herts.
Tel.: ELStree 1382 (4 lines)

With the following extra devices, the installation can also be made suitable for the production of liquid air during the periods that cooling of the box is not required:

1. Special ice separator, Type PW 7187.
2. Liquid air delivery pipe, Type PW 7101.

Among applications for the cold box installation are: preservation of chemicals and materials during transport and/or storage; preservation of biological materials such as bone, tissue, skin, etc., low temperature treatment of metals; shrink fitting; prevention of ageing of aluminium and magnesium alloys; chilling of stainless steel; environmental testing of electrical components; low temperature chemistry.

Circle **20** *for further details.*

Transistor Testers Types TM4 and TM5

THESE portable instruments measure the large and small d.c. current gains of p-n-p and n-p-n transistors, the values of resistances, and the leakage currents of diodes, transistors and low voltage electrolytic condensers. The two types of instrument differ in respect of their measurement ranges; the TM5 caters for tests on transistors at power levels to cover those used in radio receivers whilst the TM4 caters more for tests on transistors at low power levels.

Four base current ranges, at decade intervals, and four associated collector current ranges are provided for tests on germanium or silicon transistors in the common emitter connection. The base current is variable from one-fifth of full scale to the full scale value on each range and the meter may be switched to read the base current, the corresponding collector current, or the collector leakage current with the base open-circuit. Variable reverse current may be applied to the meter to balance out the leakage current on the collector current ranges so that the meter reading is proportional to the d.c. current gain factor of the transistor. The collector current ranges are 100 times greater than the associated base current ranges, thus the current gain is read on a scale of 0-100 when the base current is initially set to the full scale value. A current gain range of 0-500 is obtained when the base current is initially set to one-fifth of the full scale value. The small signal gain factor may be evaluated from the observed change of collector current that is produced by a small change of the base current.

The collector current supply is obtained from a battery of nominal potential 3 volts and it is arranged that the base current can be set to the full scale reading only when this battery has a potential greater than 2 volts. The collector current meter drops 1 volt at f.s.d. so that the collector test potential is between 1 and 3 volts.

Two ohms ranges are provided at a decade apart for the measurement of resistances. The ohms zero control varies the equivalent source voltage of the circuit between 1 and 6 volts and the meter drops approximately 5 volts at full scale deflection on both of these ranges. These ranges can also be used directly for the measurement of the leakage currents of diodes, transistors and low voltage electrolytic condensers at potentials up to 6 volts. In addition, the supply may be boosted up to 30 volts, by external batteries, without fear of damage to the instrument when the test leads are shorted.

Circle **21** *for further details.*

"X" and "Y" Co-ordinate Plotting Table

THE plotting table has been designed as a simple analogue device in which the pen position along the "X" and "Y" axes is proportional to the d.c. signals applied to these axes. It also has a time-base incorporated, which may be switched into the "X" axis, so that the table may be used for plotting any function against time and so becomes a low speed recording oscilloscope.

It will have applications in servo performance analysis, plotting frequency response of equipment, drawing stress-strain diagrams of materials, or any other application where the two functions to be graphed can be represented by the voltages.

In test houses and production lines it may be used to draw automatically calibration curves of equipment.

When used with the point plotting keyboard attachment, it will be of use commercially for plotting curves from tabulated data, such as obtained from data computers or from elaborate statistical data.

It has a graphing area of 15 × 10 in. anp will take standard graph paper. The paper is held down by a vacuum system. A pen of the capillary type is used and is traversed in the "X" and "Y" directions by a system of wires, thus ensuring a minimum of backlash. The pen is driven by a split field motor for each axis and its position is measured by precision potentiometers running the length and breadth of the table.

The sensitivity or scale factor of each axis is infinitely variable over a range of 0·08 to 8·0 volts per inch by means of a coarse and fine control on each axis.

The pen may be positioned anywhere over the whole writing area by means of the "X" and "Y" pen shift controls. These controls are ten turn potentiometers providing ease and accuracy of pen positioning.

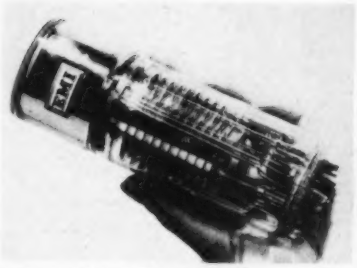
The time-base has a series of time positions and a fine control is obtained on the "X" scale factor fine control knob providing a continuously variable sweep rate from 0·1 to 10 inches per second. The time-base is triggered by means of a push-button on the front panel or by a circuit in the signal plug for external synchronisation. Automatic "fly-back" is provided and the pen is lifted at the end of the time-base sweep.

The table has a high rate of response; the maximum pen velocity being greater than 20 inches/second. The full excursion on the "Y" axis of 10 in. peak to peak may be obtained up to frequencies of 0·75 cycles per second. For amplitudes within the limitations of maximum pen velocity, the pen response is such that the amplitude is reduced to 70% of the d.c. value (i.e., 3 dB down) at 5 cycles per second.

The plotting accuracy of the table is about 0·1% of full scale.

The price of the instrument is £580.

Circle **22** *for further details.*



Photomultiplier tube, type 9558B

Photomultiplier Tube

THE photomultiplier tube Type 9558B, which has a tri-alkali photo-cathode formed from antimony sodium potassium caesium is characterised by a high quantum efficiency of between 15 and 20% in the blue region (at 4,200Å) and an extended red response up to 8,500Å, while having at the same time a low value of dark current. A typical tube has a photo sensitivity of 100 μA/lm, an overall sensitivity of 200 μA/lm at an average of 1,700 volts and a dark current under these conditions of 0·003 μA. These tubes are especially suitable for application in spectrometry, particularly flame spectrometry and for scintillation counting with materials such as caesium iodide and also for scintillation counting of C^{14} and H^3.

Circle **23** *for further details.*

Cleaning Fabric for Precision Instruments

A NEW open-mesh fabric has been developed specifically for cleaning processes during the manufacture of precision equipment, and it is now available to the trade. The fabric does not shed lint or dust, while it will absorb moisture, fluids or oils.

The fabric (Quality V.9039) depends for its properties on a puffed viscose yarn. This is a continuous filament yarn, so that there are no short fibres which could break free from the yarn to cause contamination. It has many of the characteristics of a spun yarn, however, for the texturing process produces minute loops along the length of the filaments and these result in the greatly increased absorbency which is required in a cleaning cloth.

An additional feature of the design of the cloth is the provision of "cutting channels" along both the warp and the weft. These ensure that when cleaning rags are taken from the piece, the cutting blade only passes at right angles to the threads, so that there is no danger of a small part of any thread becoming separated and thereby causing loose fibres. These cutting channels are spaced at 18 in. intervals.

Circle **24** *for further details.*

Detector for Liquid Gases

A SENSING unit that detects the presence or absence of liquid gases or cryogenic fuels in a transfer line or vessel is now being marketed.

The detector is a three-part control unit consisting of a probe, amplifier and connecting coaxial cable.

The probe consists of a series of Teflon-spaced stainless steel concentric cylinders.

When the probe is inserted in a vessel or transfer line, the presence or absence of a liquid results in a change in capacitance as the liquid fills the space between the cylinders. This measured change is transmitted by coaxial cable through an explosion-proof flexible conduit to a transistorised amplifier where it is converted to energise a double-pole double-throw relay.

The amplifier, housed in an explosion-proof conduit box, has four computer-type transistors. Coupling and impedance matching is accomplished by means of iron core transformers. Current feedback is used for stability, and temperature compensation is obtained by a thermistor circuit.

The probe detects level of liquid gases and fuels within one-sixteenth inch or less and will withstand maximum pressure of 250 p.s.i. at −297°F and liquid velocity of 18 feet per second. The amplifier operates within an ambient temperature range of 0 to 140°F. Provision is made for testing by remote contact closure which results in simulating the presence of a liquid.

Circle **25** *for further details.*

Oscilloscope for High Frequency Pulse Monitoring

A PULSE monitoring oscilloscope, Type L 362, with rise-time of 2 milli-microseconds, has been designed for the display or measurement of pulses of between 3 milli-microseconds and 3 microseconds duration.

The sensitivity is 150 mV/cm, which, combined with the d.c. coupled amplifiers, makes the instrument particularly suitable for work on transistor circuits. The input probe imposes a load of only 2 pF on the circuit under investigation. Due to the extensive use of transistors, the instrument is portable and compact, weighing only 27 lb and measuring $14\frac{1}{2} \times 8\frac{3}{4} \times 18\frac{1}{2}$ in.

Circle **26** *for further details.*

Centrifuges

CENTRIFUGES are available which have a choice of four speeds, the maximum being approximately 5,000 r.p.m. and with 4 or 6 place angle head. The motor is cushioned and the spindle is self centring in operation.

The following models are available:

4 place for 5 ml tubes, "Baby-micro", £15 15s. 0d.
4 place for 15 ml tubes, "Baby-standard", £15 15s. 0d.
6 place for 5 ml tubes, "Junior-micro", £17 17s. 0d.
6 place for 15 ml tubes, "Junior-standard", £17 17s. 0d.

Circle **27** *for further details.*

Electronic Counting Units

Two types of counting units designed for use as "building-bricks" for industrial electronic counting and control systems have been introduced.

One is a conventional type of counter capable of a counting rate of 30,000 a second and intended for applications where the counter is not required to exercise any direct control over the machine or process. The other is a pre-set counter which can be programmed to issue up to 10 command signals to the controlled machine once the count has reached specified values.

Pre-set Counter Type 89930

The basic pre-set counting unit provides a single decade of counting at speeds up to 2,000 a second. The counting elements consist of cold cathode trigger tubes, the glow discharges of which give a visual indication of the count registered. All connections to the unit are by plug and socket so that a number of decades can readily be connected in series to give any required counting capacity.

Each decade unit has two independent programme channels which can be pre-set by means of rotary switches to issue command signals to the controlled mechanism or machine when the count reaches pre-determined values.

The counter may be operated from any normal type of input transducer, and a transistorised pulse-forming unit is available to convert the output from such devices into a pulse of suitable shape to operate the trigger tubes.

Decade Counting Unit, Type 89929

This unit is intended as a "building-brick" for general purpose counting equipment where the counter is not required to produce command signals for control purposes. It is capable of counting speeds of up to 30,000 a second, and special add-on units are available to increase the speed up to 100,000 a second. The basic unit consists essentially of an E1T decade tube, giving direct visual indication of the count, driven by a monostable multivibrator circuit. All connections are made by a single plug and socket so that a number of decades can readily be connected in series to give any counting capacity.

Circle **28** *for further details.*

Synchro Resolvers Types 11RI3N4, 11R2N4

THESE resolvers conform to the American BuOrd Size 11, having two separate phases on the stator and two phases with one common terminal on the rotor. The output is a sine and cosine expression of the angular position of the rotor and the resolvers are used in computer networks to rotate rectangular co-ordinates or for the conversion of Cartesian co-ordinates to polar co-ordinates or *vice-versa*.

Synchro resolver

Two types are available, the 11R13N4 having a high impedance, and the 11R2N4 for a low impedance application. The 11R2N4 is particularly suitable for high frequency operation and has been used successfully on 10 kc systems.

Electrical Characteristics
(Average with rotor as primary)

	11R13N4	11R2N4
Input voltage at 400 cycles, volts	26	26
Input current, milliamps ...	20	52
Input power, watts ...	0·15	0·34
Transformation ratio	0·846	0·490
Voltage gradient, volts/degree ...	0·38	0·22
D.C. resistance rotor, ohms ...	200	14
D.C. resistance stator, ohms ...	130	76
Phase shift, degrees	7°	10°
Residual voltage, total, millivolts	58	27
Residual voltage, fundamental, millivolts ...	38	17
Electrical error, minutes ...	7 max.	7 max.

Mechanical Characteristics

Operating temperature range	−50°C to + 100°C
Friction 25°C ...	4 gm cm max.
Rotor moment of inertia ...	2 gm cm
Shaft end play ...	0·0015 max.
Shaft radial play ...	0·0005 max.

Small quantities of either type can usually be supplied from stock.

Circle **29** *for further details.*

Napier-O.M.T. Contour and Profile Projector

A DESIGN feature of the projector is the method adopted to explore the contour being inspected. Hitherto this has been done by a feeler attached to the top slide of a compound table and in contact with the stationary workpiece, movements of the feeler being reproduced by a lens or a graticule positioned on the same slide.

On the Napier-OMT projector, however, the work is rotated and first contacted by a feeler mounted on the extremity of a pivot arm; this is urged yieldingly against the contour and its movements are recorded by a lens attached to the opposite end of the arm. This method has the merit that very abrupt changes of contour, such as travelling round either the leading or trailing edge of a turbine blade, can be explored without difficulty.

A pivoted arm carrying at one extremity a circular disc feeler is located against the contour to be explored, whilst at the reverse end of the arm, on the other side of the pivot, is mounted an objective lens, with its optical axis equally distant to the centre of the feeler disc from the pivot axis.

To explore the contour, the holder containing the blade is rotated, thereby causing the pivoted arm to swing in an arc. The projection lens swings in a corresponding arc over a graticule carrying the correct form of the cross-section being inspected, this graticule being connected

to the blade holder so that it rotates through the same angle as the holder.

Situated above the projection lens is a fixed collimation lens, this projects the image of the rotating graticule on to the screen which carries a semi-circular fiducial mark with appropriate tolerance zones. As the blade is rotated, the 20× image of the graticule blade-form rotates round the semi-circle on the screen and errors are displayed by the deviations of the graticule form image from the fiducial circle markings on the screen.

It is also possible to analyse the errors of a blade cross-section into:

(a) lean or displacement of the blade-form from the stacking line

(b) twist or rotation of the blade section

(c) form errors.

Having eliminated on the screen the errors of twist and lean from the blade-form, the contour check may be carried out, and in order to check different cross-sections on the same workpiece the feeler arm can be moved up or down its locating pillar, a series of pre-set adjustable stops being used to locate each position.

The capacity of the instrument is as follows:—

Maximum cross-section which can be checked	2·6 in.
Maximum inspectable length of workpiece	6·0 in.
Screen size	24 × 16 in.

Circle **30** *for further details.*

Four Function Combination Control for Warm Air Furnaces

A COMBINATION control has been developed which programmes both fan and burner on gas or oil fired plenum heating or warm air furnaces, in accordance with temperatures selected at the control. When used in conjunction with a room thermostat and oil burner flame failure safeguard and relay, the combination control provides a complete warm air heating control system. The new control also features a manual switch on the front cover which will override the automatic functions of the controller and run the fan continuously, thus providing summer ventilation. Mounted in the plenum or warm air chamber of the furnace, the control maintains the following regime.

Combination control for furnaces

When the room thermostat calls for heat, the control ensures that the plenum fan will not operate until the temperature in the plenum has reached a comfortable level. Should the temperature in the plenum then rise to a dangerous level, the combination control switches off the oil burner through the oil burner flame failure safeguard and relay, and continues to operate the fan until the room thermostat is satisfied or the temperature in the plenum drops, when it will refire the oil burner.

The combination control may be used in line and low voltage circuits. The scale settings for selecting temperatures at which the control will switch the fan on and off and provide limit control on the burner are easily adjusted and readings for each are visible through a window in the cover.

Circle **31** *for further details.*

Florite and Floret Air Velocity Indicators

THE Florite is a circular instrument with a die-cast housing, 4 in. in diameter and 1¾ in. deep. The rotating peripheral scale, 8 in. long, gives direct readings in feet per minute or miles per hour. No charts, calculations or other aids are needed. Two scale ranges are available, 0-1,000 ft/min and 0-3,000 ft/min, the latter scale also bearing graduations in m.p.h.

The readings are automatically averaged over an area 3 in. in diameter, and accuracy is guaranteed within 2% of full scale reading. A zero adjustment is provided.

In operation, the Florite is simply held to the air flow and the reading taken. The rotor is magnetically damped to level out insignificant variations in velocity and to bring the scale rapidly to rest.

Two models of the Florite are offered. Model MRF is for normal use, Model MDL is fitted with a special scoop for measuring air flow from square or circular ceiling diffusers or louvres.

The price of the Florite, with handle and carrying case, is £22 10s. 0d.

The Floret is a pocket instrument providing instant direct readings on a 2½ in. long sector-scale, graduated in equal-sized divisions from 0-1,000 feet per minute. It is self-contained and requires no hose, probe or other auxiliary fittings. It operates in any position.

The Floret works on the deflecting vane principle, the air entering through a small hole in the base of the moulded plastic case. A simple positive zero adjustment is provided.

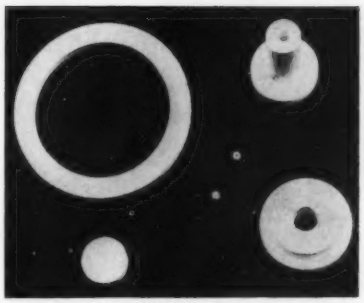
This instrument, 4⅝ in. × 2⅞ in. × 1 in. overall, is suitable for checking and balancing heating, ventilating and other air circulation systems. Complete in snap-fastener case, it costs £8 10s. 0d.

Circle **32** *for further details.*

"Fluorosint"

"FLUOROSINT" is a fluorocarbon t.f.e. base resin comprising polytetrafluoroethylene (p.t.f.e.) and other constituents designed to improve the mechanical and thermal properties of p.t.f.e. without materially affecting its electrical and chemical characteristics.

The coefficient of thermal expansion is approximately ⅓ that of p.t.f.e., and is similar to aluminium, copper, and a number of other metals.



"Fluorosint" mouldings

Dimensional tolerances of parts in "Fluorosint" can be held to limits that are ⅓ to ⅛ those attainable with p.t.f.e. "Fluorosint" parts are said to be free of stresses and do not distort on thermal shock or temperature cycling. Deformation under load is less than p.t.f.e., especially at elevated temperatures. Hardness is increased and creep or cold flow greatly reduced.

Bearing and wear characteristics show an improvement over p.t.f.e. Bearings can operate at much higher loads and speeds (PVs over 15,000).

The electrical properties are closely comparable to p.t.f.e. over the entire frequency range and chemical properties very alike.

"Fluorosint" is similar to p.t.f.e. in that it is resistant to almost all chemicals. Its chemical resistance combined with its outstanding mechanical properties permits "Fluorosint" to be used for bearings and bushings operating in corrosive conditions or under water, as well as for gaskets, packings, washers, valve seats and similar parts.

"Fluorosint" is available in the form of rod and tubular bars for fabrication into component parts or, alternatively, parts can be moulded to customers' requirements.

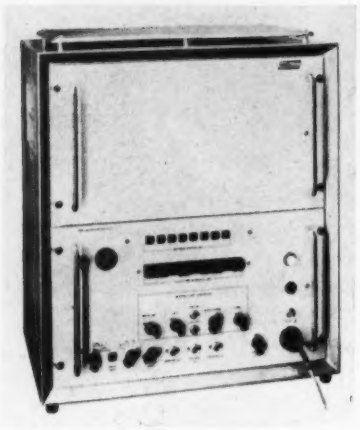
Circle **33** *for further details.*

Time Calibrator Unit

THE time calibrator unit is known as Type CU3A.

The time intervals, which range from 0·5 microsecond to 1 millisecond, are selected by means of press-button switches. Each switch remains depressed until a 'cancel' button is operated, thus a mixed output of markers may be obtained. The markers mix additively so as to facilitate counting. Both positive and negative-going outputs are available and, at the same time, one or more individual time markers may be derived from sockets on the panel. The latter outputs are connected before the push-button switches and are independent of the switch positions.

The marker accuracy is checked against an internal 2 Mc/s crystal. Markers may be free-running or keyed from a square wave source. Apart from the free-running mode it is possible to operate the unit with an external keying source, with an internal source synchronised to an external waveform or with external apparatus triggered by, or synchronised to, the internal keying source. Typically, the unit might be used to check the calibration of



Time calibrator unit

an oscilloscope time-base. In this case, a square wave derived from the time-base, could be used to key the time calibrator and a stable display would be obtained regardless of any alterations to the oscilloscope control settings.

The price is £260 and delivery is two to three weeks.

Circle **34** *for further details.*

Hygrometer Alarm

THIS hygrometer will detect one part of water vapour per million parts of dry air or gas. It will also operate under high pressure, temperature or humidity conditions.

The sensing of moisture is done by a variable capacitance.

Two types of element are available.

The ordinary element indicates in less than one second the difference in humidity at ground level and that at 4 ft above ground level. The element is protected by a stainless steel wire mesh cover in 200 gauge wire. The maximum temperature limit is 150°C. Range is 10%—100% r.h. at ambient temperatures. It can be used to record or indicate humidity conditions in drying ovens of all types, to give immediate indication of sudden humidity changes, to give an indication of moisture content of various materials during processing, and for use where an immediate indication of changes in humidity is required, particularly in the range below 60% r.h. where hair type hygrometers are not satisfactory.

The element with an increased sensitivity will indicate the difference in relative humidity between dry silica gel and P_2O_5. Suitable for dry gases. Maximum temperature 150°C. Sensitivity one part water vapour per million parts of air or gas. It can be used to record or indicate moisture content of dry industrial gases, to indicate the efficiency of drying systems using desiccants, and to monitor dry atmospheres as used in the manufacture of semiconductor devices.

Ordinary and sensitive elements are available in ambient or pressure type mountings. Spare elements are £5 each (not supplied separately).

The small detecting element consists of a capacitor with a hygroscopic dielectric, only a few microns thick with a 24 carat gold electrode. The variation in capacitance caused by the alteration of the moisture content of the dielectric is indicated on the dial of the hygrometer.

The detector is contained in a small, strong, fine wire gauze protector which plugs into a coaxial cable connecting it to the recorder. The detecting element is 1 cm in diameter and 6 cm long, and can be used with any length of cable.

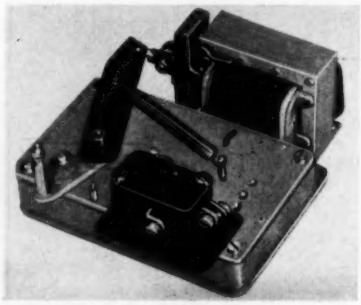
Circle **35** *for further details.*

Motor Control Unit Type MCU

THE control unit, Type MCU, closes alternately two electrical circuits for continuously adjustable periods at continuously adjustable intervals with the overall timing cycle remaining always constant.

Control unit MCU is supplied in three standard variations:

(a) With control unit MCU/A, pressing of the start push button on the unit or pressing of an external start push button connected to terminals of the unit energises an internal timer which closes alternately two electrical circuits (which are usually connected to contactor coils reversing the motors) with an adjustable interval between alternate closing to allow the motors to come to a standstill. Pressing of the reset push button on the unit or of



Motor control unit type MCU

an external reset push button wired to the terminals of the unit resets the internal timer automatically within half a second if the overall timing period is one month and, at the same time, the coils of both motor contactors are de-energised. Two indicator lights show if the motor is running in forward or reverse direction and another light gives indication of voltage supply.

(b) Control Unit MCU/B energises alternately two motor contactor coils for continuously adjustable periods at continuously adjustable intervals with the overall timing cycle remaining constant but the unit does not reset to zero position on power failure. Disconnection of the voltage supply stops the unit. Timing action is continued on restoration of input voltage. The unit is provided as standard in an enclosure similar to unit MCU/A with three indicator lights, but without push buttons.

(c) Control unit MCU/S gives the same facilities as unit MCU/A. However, not only the individual 'on' and 'off' periods but also the overall timing period are continuously and independently adjustable.

All units, Type MCU, can be supplied for the overall timing period between 10 seconds and 30 days. The minimum timed interval which may be preset equals approximately one-sixtieth of the overall timing period.

The switching capacity is 6 amp and 250 V a.c. or 110 V a.c.

Prices range from £8 10s. 0d., and the delivery time is 4/6 weeks.

Circle **36** *for further details.*

Pneumatic Selector Relay

A RELAY which will accept two signals in the 0-100 p.s.i. range and always pass the higher signal is known as the model 58S, and it is intended to complement the Sunvic Model 61F booster relay which is a minimum auto-selector.

The Model 58S relay will operate in ambient temperature from —40 to +180°F. Maximum operating pressure is 100 p.s.i. As there is no retransmission, there is no time delay.

Circle **37** *for further details.*

Safety Shut-off Solenoid Valve

'ALCON' Type ACOH midget hand re-set solenoid safety shut-off valve is suitable for use with air, gas or oil; connections are ¼ in. B.S.P. This unit is a midget version of standard hand re-set safety shut-off valve, chiefly used for ensuring complete shut-off of fuel oil or gas in the event of electrical failure or operation of any safety limit switches with which it is connected. Upon current being restored, valve will not open until manual re-set button has been operated.

Circle **38** *for further details.*

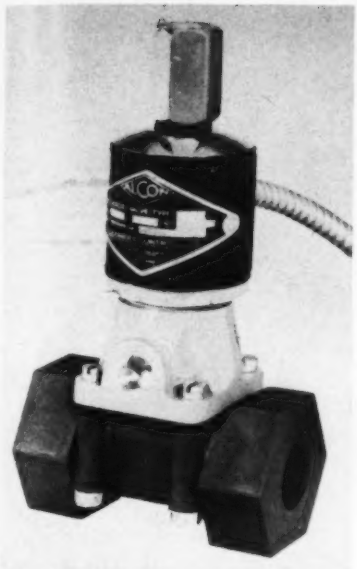
Portable Potentiometer and Pyrometer Tester

A SMALLER and lighter portable potentiometer and pyrometer tester is available in which the weight has been reduced to approximately 13½ lb from 26½ lb, and the bulk is reduced to 737 in.³ from 1,222 in.³

There is also provision for measuring electrical resistance with the orders met with in pyrometry—roughly from 0·06 ohms to 600 ohms.

Circle **39** *for further details.*

Portable potentiometer and pyrometer tester



Solenoid valve for control of de-ionised water

Solenoid Valve for Control of De-ionised Water

THE 'Alcon' Type AOD/KD/AC.30 air operated, electrical pilot controlled valve is available in sizes up to and including 1 in. B.S.P. The main valve seating consists of a diaphragm which is pressurised to ensure closure by means of the midget electrically operated pilot valve. This type of valve can be supplied having metal, plastic, ebonite or fibre body and can be fitted with diaphragm of suitable alternative materials enabling corrosive gases or liquids to be handled. It has been primarily developed to cover applications such as the control of de-ionised water, where the medium passing through the valve cannot be permitted to be in contact with any metal component. Units can be supplied energised to open, or energised to close according to requirements.

Circle **40** *for further details.*

Unit System for Reactor Instruments

A SYSTEM of nuclear reactor instrumentation has been designed which is aimed at maximum flexibility by use of a number of small standard units.

Each basic unit contains one or, at the most, two circuits performing a certain function and standard items can be combined to meet any accepted reactor control channel specification.

The units are runner-mounted in trays so that their front plates are 2½ in. behind the normal front panel position when the trays are in a 19 in. rack. From damped arms hinged to each tray is suspended a front panel carrying meters and indicating lamps for all units in that tray. This front panel hinges forward and down to allow withdrawal of the units and access to the controls on their front plates, which measure 7 in. high × 3⅛ in. wide (or multiples of that width). Meters on the lowered front panel are visible while the corresponding controls on the unit front plates are being adjusted. When the front is locked up in position, however, all controls are protected from unauthorised adjustment, but meters and indicators remain visible.

Front panel layout is to customer's requirements as is wiring of the trays. To cater for widely differing arrangements, each unit contains a heater transformer. A separate unit is provided for h.t. supplies. Maximum ease of circuit rearrangement is achieved by extensive use of vertically-mounted printed boards. Ventilation is on the "hopper" principle, each tray forming the top cover for units in the tray below.

Circle **41** *for further details.*

Di-met Diamond Abrasive Wheels

TYPE DIT metal-bonded wheels are available in thicknesses from 0·006 in. to 0·020 in. with flush blades 2 in. to 5 in. in diameter, and diamond depth $\frac{1}{16}$ in. or $\frac{1}{8}$ in. These fine blades are useful in the electronics industry for the slicing, dicing and wafering of such materials as quartz, germanium and silicon.

Type DITR, available in a choice of two bond types—metallic or resinoid—are specially produced for the cutting of semi-precious stones, glass, ceramics, tungsten carbide, etc., In this type, the blades are relieved at the side. Sizes: 3 in. to 14 in. diameter, 0·025 in. to 0·062 in. thick. Diamond depth is $\frac{1}{16}$ in. or $\frac{1}{8}$ in.

Types DIT and DITR are both available with a wide variety of grit sizes and arbor holes. Concentricity is accurate to within 0·001 in.

Di-met 'Rimlock' wheels, a third type, are low-cost diamond abrasive wheels for the rapid cutting of hard, brittle non-metallic materials, with applications in the ceramics industry, and in geology, mineralogy and petrology. The sharp-edged diamond particles are locked in the wheel rim. These wheels, for wet operation, are available in diameters from 3 in. to 36 in. and with arbor holes to fit any machine.

Circle **42** *for further details.*

Relays for Liquid Level Measurement

FIVE different types of constant differential relay are now available with built-in variable area flow meter (Rotameter) and needle valve. These relays can be used to ensure a constant bubbling rate of purging air or gas in air reaction systems for liquid level measurement.

Precise flow control of the purge medium is necessary if measurement accuracy is not to be affected by variations in bubble size or by variable kinetic heads across the dip tube.

No liquid whatsoever is used in the purge flow controller and so no maintenance is required. Instead of visual indications of purge rate by bubbling, an accurate flow meter, with easily read calibrations is provided. The unit is rated at 50 p.s.i. static pressure and tested at 100 p.s.i. static pressure.

Model 62A relays use a high-precision bleed-type regulator which has the advantage of releasing any surge from downstream. The body is of brass with Neoprene diaphragm and stainless steel valve and spring.

Model 63A relays are non-bleed and are, therefore, ideal for use with liquids as well as expensive purge media such as helium or CO_2 or with inflammable gases. Two versions are available: one for use when up-stream pressure can be held constant, one for constant downstream pressure. Construction materials are as for Model 62A. Both versions are also available in a stainless steel body with Teflon diaphragm.

Circle **43** *for further details.*

Electrothermal Glass Tube Cutter

THIS apparatus provides an easily operated means of cutting hard (borosilicate) or soft glass, up to 3 in. (7·6 cm) in diameter.

The tube is rotated against the cutting wheel and the resulting scratch mark is then held against the hot wire, localised heat causing the tube to part. An adjustable backstop makes sure that the scratch is cut accurately around the circumference of the tube.

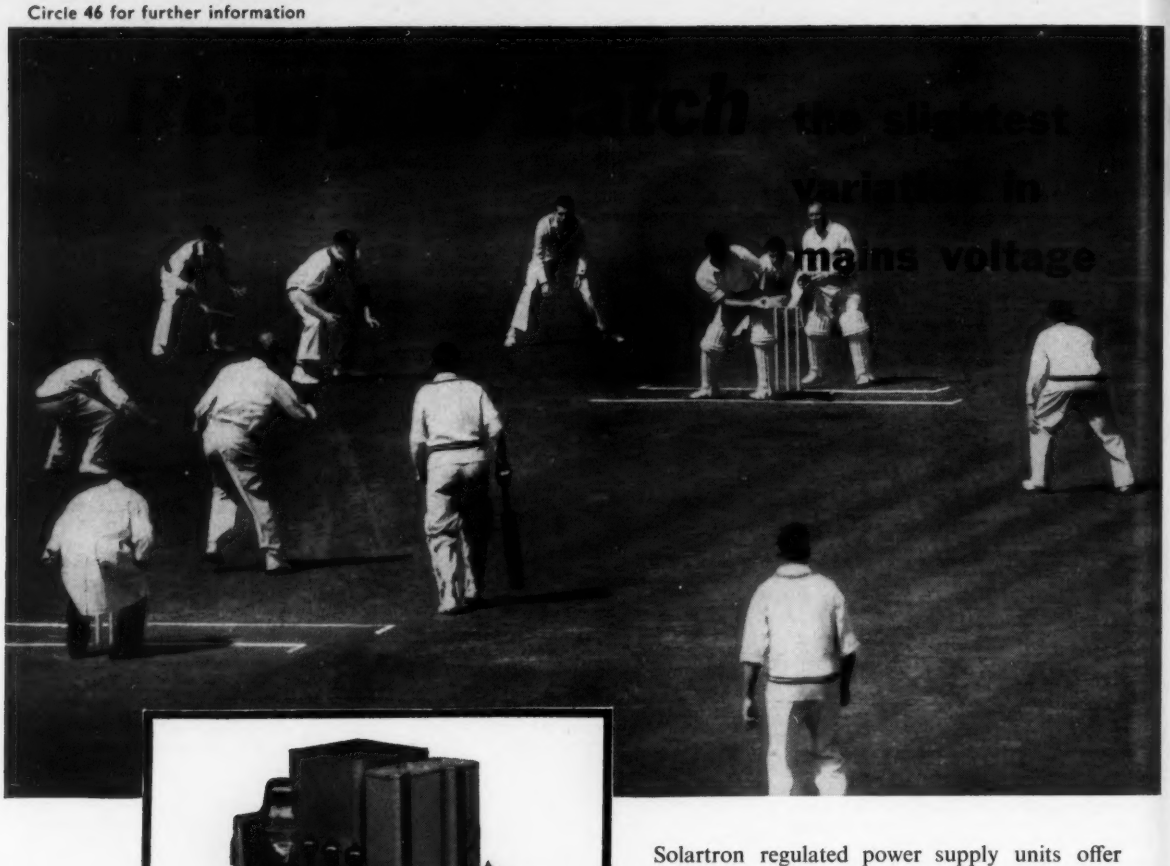
To provide extra low voltage for heating the wire, the equipment contains a double-wound transformer fitted, for safety, with an earthed screen between primary and secondary. In addition, the weight of the transformer lends stability to the whole apparatus.

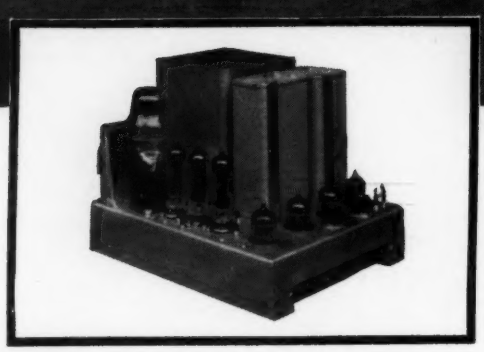
On the front of the top plate are mounted the guide, backstop, and cutting wheel holder. Six standard cutting wheels are provided in one unit, and are rotated out of the way as they become blunt. They can be replaced easily. At the back of the top plate are two pillars, between which the replaceable nickel/chrome wire is connected. The apparatus is supplied for use on 200/250 V or 100/120 V as required with 20 ft of 27 s.w.g. nickel/chrome wire and a set of six cutting wheels.

Circle **44** *for further details.*

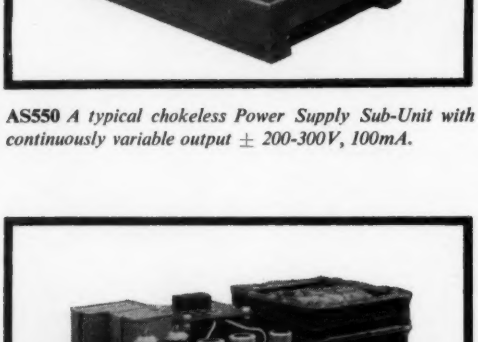
Glass tube cutter

Circle 46 for further information





AS550 *A typical chokeless Power Supply Sub-Unit with continuously variable output ± 200-300V, 100mA.*



AS754 *A Sub-Unit giving ± 250-300V at up to 200mA.*

Solartron regulated power supply units offer a ready made and absolutely reliable source of packaged power, either for separate use, or direct incorporation into prototype and production equipment, including computers, simulators, industrial controls, etc.

- ★ *Stable under all conditions.*
- ★ *Robustly made.*
- ★ *Completely reliable.*
- ★ *Light, compact, inexpensive.*
- ★ *Easy to fit.*
- ★ *Exceptionally useful as bench instruments for educational and servicing establishments.*

Write to :

THE SOLARTRON ELECTRONIC GROUP LIMITED

THAMES DITTON · SURREY

Telephone: EMBerbrook 5522. Cables: Solartron, Thames Ditton

International Telex: 23842 Solartron T.Dit.

SOLARTRON

NEWS OF THE INDUSTRY

Plessey Nucleonics Works Extension

An extension to the Northampton factory of Plessey Nucleonics Limited was opened recently by Sir John Cockcroft, Research Member of the United Kingdom Atomic Energy Authority.

On arrival at the factory, Sir John was welcomed by Mr. A. G. Clark, Chairman of The Plessey Company Limited, Dr. Denis Taylor, a Director and General Manager of Plessey Nucleonics Limited, and other Plessey Group Directors.

After the opening, Sir John toured the factory at which are being manufactured burst slug detection equipment for nuclear reactors, health and plant safety apparatus and products used in nuclear instrumentation. Currently in production are burst slug detection systems for Hinkley Point and Latina (Italy) nuclear power stations. Burst slug detection equipment is also in production for DIDO, PLUTO and DMTR research reactors in this country and for the German research reactor at Karlsruhe.

During the tour, visitors saw a demonstration of a new plutonium monitor, a further example of the original and specialised work carried out by Plessey Nucleonics Limited. The monitor, primarily developed for the detection and location of minute quantities of plutonium which may accidentally enter the human body, has wide applications both in the laboratory and in the field.

Present at the opening were leading personalities in the aircraft, electrical and nuclear power industries.

Radiation Monitoring and Tracer Service

A commercial Radiation Monitoring and Tracer Service is being launched in this country to cater for the ever-increasing use of isotopes. It is a comprehensive service for the benefit of all branches of industry, medicine and scientific research and it is organised by Ekco Electronics Ltd., of Southend-on-Sea.

The service offered falls broadly into three groups as follows:

Group 1 is aimed at helping industry to achieve the requirements of the impending Factories (Ionising Radiations) Special Regulations. It includes carrying out site surveys and testing sources of radiation on the premises of users of industrial nucleonic equipment such as thickness and level gauges, X-ray machines, etc.

Group 2 is a specialised service offered to Public Health Authorities and includes the measurement of radioactivity in air, water, sewage, etc.

Group 3 is a service for the benefit of industrial and scientific research. It allows for the carrying out of tracer experiments by skilled personnel without the need for purchasing the complex equipment involved. It will enable many kinds of research to be speeded up where previously the advantages of radioactive tracer technique have been barred by the high cost of equipment and training in relation to a single experiment.

Name Change

Besson & Robinson Ltd. have changed their name to B & R Relays Ltd. In making this decision, the Managing Director, Mr. H. S. Payman, said that it had been felt that a name more closely describing the products of the Company should be used and that the initials B & R confirmed popular usage.

International Compressed Air and Hydraulics Exhibition

The exhibition, which takes place at Olympia from 25th-29th April, 1960, is the first of its kind and is designed to meet the growing desire of those concerned in the manufacture and application of fluid power to demonstrate every aspect of their industrial and commercial progress.

Haddon Transformers' New Factory

Haddon Transformers Ltd., of Masons Avenue, Wealdstone, Harrow, announce that the work at its new factory at Ruislip has progressed sufficiently for it to be occupied.

The Head Office, Administration Block, Design Departments, and Main Works transfer to Victoria Park Industrial Estate, Field End Road, Ruislip, Middx. (telephone Byron 9444) was effected recently.

With the capacity for raising production from the present factories nearing its limit, the development of the new site and new works cater for the volume of orders which have been increasing in the past three or four years, and as the number of orders increase (as indicated by the present rising demand for their products) they are now able to accept them with a shorter and more reasonable period of delivery than before, the additional shops having bays of wide span and height, and crane installations, the production of saturable reactors, transductors, heavy power transformers are greatly facilitated.

The mass production units for quantity production of small transformers are now streamlined to give greater efficiency. The Masons Avenue works are being retained to ensure a smooth change-over and afterwards assist as an extension production unit.

Anglo-U.S. Nuclear Equipment Company

The setting up of an Anglo-American company to specialise in the design, manufacture and marketing of remote-controlled nuclear handling apparatus has been announced jointly by Savage & Parsons Ltd. (Watford, Herts.) and General Mills Inc. (Minneapolis, Minnesota, U.S.A.). The new company, Nuclear Equipment Ltd., will have its head office at Otterspool Way, Watford.

This new organisation will maintain close contact with nuclear establishments throughout the world, with the exception of the U.S.A., although its prime markets will be in the British Commonwealth and Western Europe. The company will be concerned with both mechanical and powered manipulators, reactor fuel loading and unloading system, reactor maintenance systems, and other types of handling apparatus and ancillary protective equipment.

The board of Nuclear Equipment Ltd. will consist of Mr. J. B. Savage (managing director) and Mr. G. A. Lingham, D.F.C., both directors of Savage & Parsons Ltd., and Mr. W. A. Stephens, assistant general manager of the Mechanical Division of General Mills Inc., and Mr. G. O. Haglund, director of that Division's Nuclear Equipment Department.

The controlling interest is held by the British partner, who has been concerned with the design and manufacture of this type of equipment since 1954.

Within the past 12 months there has been an increasing demand for remote handling devices from overseas countries, and this is one of the reasons behind the formation of the new company.

Conference on "Some Aspects of Magnetism"

Details of The Institute of Physics' Conference on "Some aspects of magnetism", and forms of application to attend it, are now available from the Secretary of the Institute at 47 Belgrave Square, London, S.W.1. The Conference will take place in Sheffield from 22nd-24th September next.

Measuring Strontium-90

A more accurate way for measuring Strontium-90 has been developed recently. It is based on an atomic-absorption technique. It differs in an important respect from flame spectrophotometry and avoids the most serious defect of that method, which is interference from other elements in the sample. In the new technique, the atoms do not have to be excited in a flame but are detected in their normal unexcited condition.

The new method was invented, and to a great extent developed, by Dr. A. Walsh, in Australia, and it has been worked on and put on the market in this country by Hilger & Watts Ltd., of London.

6th International Congress of T.I.M.S.

FROM 7th-10th September an international congress in the field of management sciences was held at the Conservatoire National des Arts and Métiers, in Paris.

Up to now, T.I.M.S. (the Institute of Management Sciences) has held its meetings in the United States, but the development of research in the sphere of management sciences in Europe has made it possible for T.I.M.S. to meet in Paris this year. The 1959 T.I.M.S. Congress in Paris enabled experts from all countries to obtain a picture of the efforts made the world over to understand the structure and the laws of organisation and management systems.

The Congress was open to all persons who wished to acquaint themselves with the latest developments in the domain of organisation and management sciences.

For all information, apply to the Service de Presse-Public-Relations, Rue Il-Malmaison (Seine & Oise) France.

Thomas Mercer Ltd.

MESSRS. THOMAS MERCER LTD. have acquired a majority shareholding in the business of Mr. John F. Tennent, of 53 St. Enoch Square, Glasgow, C.1. The newly-formed company will be known as Messrs. J. F. Tennent Ltd.; the chairman will be Mr. Frank Mercer, Mr. J. F. Tennent will be managing director and Mr. F. A. Mercer will be third director.

Messrs. J. F. Tennent Limited are the sole agents in Scotland for Messrs. W. H. Marley & Co. Ltd., and they represent Messrs. Benson Verniers Ltd., James Chesterman & Co. Ltd., Messrs. Windley Brothers Ltd., Shardlow Micrometers Ltd., and Messrs. H. Williams and Son Ltd. (Oberg products).

R. B. Pullin Awarded M.O.S. Design Approval

M.O.S. Design Approval has now been extended to cover the following classes of equipment manufactured by R. B. Pullin & Co. Ltd.:

A.C. Motors (under ¼ h.p.)
D.C. Motors (under ¼ h.p.)
A.C. Motor Generators.

£12,000 Valve Order for Siemens Edison Swan Ltd.

INDUSTRIAL VALVE DIVISION of Siemens Edison Swan Ltd. have received an order totalling £12,000 from Murphy Radio Ltd., for the supply of a new type of valve which has been specially designed to operate in their lightweight portable transmitter-receiver sets now being manufactured for the Ministry of Supply.

The CV.4097, as it has been named, is a miniature v.h.f. beam tetrode valve primarily intended for use as an r.f. power amplifier in "walkie-talkies", and mobile transmitters, up to 100 Mc/s.

The special construction of the valve will enable it to stand up to considerable mechanical strain, such as a continuous vibration at an acceleration of 2·5 G, or a short shock wave of 500 G.

Elga Products Ltd.: New Factory

IN view of the growth of the Company's Ion Exchange Division, operations have been moved to a new factory at Lane End, Bucks. Headquarters, Research and Service Regeneration are now established here.

Within four years deionisation has superseded the classical process of distillation with striking efficiency and economy. The Pharmacopœia Commision gave official recognition to the value of deionised water in 1955, when the British Pharmacopœia was changed to permit elgalised water "when distilled water is prescribed or requested".

Transistors could not be produced without regular flow of "intrinsic water". This term is now widely used for water of the highest purity: it stands for H_2O in the true sense of the formula. To provide it by evaporation has proved impracticable. Intrinsic water of the order of 16 megohm-cm is now produced at tap speed by a deioniser designed by Mr. E. W. Harmer for this purpose. Equipment cost is very low, and some 1,000 gallons of intrinsic water are produced for about 10s. 0d.

Creep Information Centre

IN response to requests from manufacturers and users of high-temperature materials, a Creep Information Centre is being set up at the National Engineering Laboratory (formerly the Mechanical Engineering Research Laboratory) at East Kilbride, so that industrial designers can more readily obtain data on the strength of high-temperature materials. It is hoped that it will become the national centre for information on the strength of high-temperature materials. All interested organisations are invited to co-operate in supplying experimental data so that the scheme may become as effective as possible.

The main object of the Centre will be to collect and tabulate all the available data on creep and rupture properties of conventional high-temperature materials. Data for British materials will be issued in an agreed form as far as considerations of commercial security allow. The scheme will later be extended to include fatigue and other mechanical properties of high-temperature materials and information about test procedures and testing machines; data on foreign materials may also be included.

A leaflet giving further details of the scope of the Creep Information Centre is available from the Laboratory. All firms and research organisations concerned with the production or use of high-temperature engineering materials are invited to participate, and to write to the Director, National Engineering Laboratory, East Kilbride, Glasgow.

The Institute of Physics

AT the Annual General Meeting of The Institute of Physics, Sir George Thomson (Master of Corpus Christi College, Cambridge), was re-elected president.

Dr. J. M. A. Lenihan was elected a vice-president; Dr. J. Taylor, honorary treasurer, and Professor F. A. Vick, honorary secretary, were re-elected. The two new ordinary members of the Board elected were Dr. V. E. Cosslett and Mr. L. Rotherham.

Southern Instruments: Scottish Distributors

THE recently formed Analytical Instruments Department of Southern Instruments Limited, Camberley, have appointed A. R. Bolton & Co., of Edinburgh, as their sole distributors for Scotland.

Firth Cleveland Group Headquarters

THE new Firth Cleveland Group Headquarters are now at Stornoway House, Cleveland Row, St. James's, London, S.W.1, where the following divisions are located: Simmonds Aerocessories Ltd., Export Sales, Surform Sales and Water Separator Divisions; Firth Cleveland Instruments Ltd., Aircraft and Industrial Instruments Sales Divisions; Landmaster Ltd., Export Sales Division, and Firth Cleveland Pumps Ltd., Sales Division.

The Sales Divisions of Simmonds Aerocessories Ltd., Spire Speed Nut and Nut and Bolt Divisions, Sheffield Wire Rope Co. Ltd., and British Lead Mills Ltd. are at Byron House, 7/9 St. James's St., London, S.W.1.

Ekco at the International Electronics and Nuclear Exhibition

CONSIDERABLE interest was shown in the Ekco nucleonic equipment displayed by Ekco Nucleare Italiana s.r.l. at the recent International Electronics and Nuclear Exhibition in Rome. Ekco equipment on show included reactor instrumentation, nucleonic gauging equipment and counting equipment for medical and research purposes.

International Exhibition of Laboratory, Measurement and Automatic Control in Chemistry

ILMAC, the International Exhibition of Laboratory, Measurement and Automatic Control in Chemistry, and two congresses will be taking place in Basle from 10th-15th November, 1959. The technical congresses are organised by the Association of Swiss Chemists and the Swiss Federation of Automatic Control, and are at the same time the 22nd Meeting of the European Federation of Chemical Engineering. The technical exhibition is being organised through the agency of the Swiss Industries Fair.

The Congress on Laboratory and Measurement to be organised by the Association of Swiss Chemists on 10th and 11th November is strictly confined to the field of chemistry. One half-day will be devoted to the discussion of each of the following: electrical methods, optical methods, separation methods and isotopic methods.

The programme of the Congress of the Swiss Federation of Automatic Control which takes place on the two following days covers automation in process engineering in the chemical and food industries, the economic aspects of automation and data processing in economics.

Protection from Radioactivity

ELLIOTT NUCLEONICS LTD., a member of the Elliott-Automation Group, has now inaugurated a new advisory and supply service for installed health monitoring equipment for areas where radioactive materials are used.

The new service is available to any concern using radioactive materials on a scale such that installed monitoring equipment is a practical consideration. The number of such concerns is increasing rapidly with the growth of the Atomic Power programme, the building of active chemical process plants and the increased use of radio-isotopes in industry; more and more people are working in areas where the level of radioactivity must be checked and where air and ground contamination must be measured.

To run the service Elliott Nucleonics has formed a panel, bringing together the knowledge and experience gained in recent years in several different fields concerned with radioactivity. The medical profession will be represented by Dr. E. H. Belcher, head of the Radio-Isotope Unit of the Post Graduate Medical School at Hammersmith Hospital, whose work in the application and effect of radioactivity on the human body is well known in medical circles. Dr. Belcher is joining the panel in a consultative capacity to Elliott Nucleonics Ltd. Mr. J. S. Eppstein, of Elliott Nucleonics, who has been working for many years in close co-operation with Harwell on safety aspects of the Nuclear Energy programme, is also a member of the panel. He will have with him engineers and physicists to advise on the various aspects of the problems.

The service will make available advice on the most appropriate types of instruments to be installed in each individual case, and the Company will undertake the system engineering, supply and installation of equipment, as may be necessary. The Company says that the panel will not be restricted in the equipment it can recommend. In some cases it is to be expected that it will recommend the use of instruments not included in the Company's own extensive and expanding range of equipment.

Second Exhibition in Belgium of Scientific and Industrial Instruments

THIS exhibition will be held from 23rd-29th October, 1959, in the Salle Internationale Rogier, Brussels.

Almost every trade catering in any way for laboratory, hospitals and industries are now represented in this exhibition

Baldwin Instrument Co.

IN 1949, when radioactive isotopes were made available by Harwell for commercial use, Baldwin Instrument Company were quick to appreciate their potential application for non-contact thickness measurement and control of materials in continuous production.

Baldwins now offer a large range of nucleonic thickness and control gauges which are employed in industries as far remote as leathercloth and lacquer, tissue paper and tyres, and the manufacture of hot and cold ferrous and non-ferrous sheet and tube.

This venture, together with the development in 1954 of a Fluid Power Division which produces control and automative equipment for all types of industry, has widened the structure of the Company's activities.

Expansion and development in these new fields has necessitated a recent move to much larger premises in the centre of Dartford and it became apparent that the title Baldwin Instrument Company was somewhat of a misnomer.

The name of the Company has, therefore, been changed to Baldwin Industrial Controls, a title which more clearly illustrates the Company's service to industry.

Practical Training Courses in Polarography: Session 1959-1960

IN response to the demand in 1958 for full-time instruction in polarography, the British Polarography Research Institute provided experimentally a number of training courses during the 1958-1959 session. These courses, which were the first five-day full-time intensive practical training courses in polarography to be held in Great Britain, proved to be a great success, and a further series has accordingly been planned, on an expanded scale, for the session 1959-1960. The range of courses offered provide comprehensive training in all aspects of polarography through lectures, instructional films and practical exercises.

The course fee is 45 gns., and applicants should have, if possible, some preliminary acquaintance with the fundamental principles of polarography.

The Polarographic Society Medal

A SILVER medal, to be known as the Polarographic Society Medal, has been designed. This medal will be awarded periodically in recognition of outstanding work in polarography, on the recommendation of a special committee.

The first award has been made to Professor J. Heyrovsky for his discovery of the polarographic method in the 1920's and for the subsequent major contributions to the subject by himself and his students.

The medal was presented by Professor W. H. Linnell, vice-president of the Polarographic Society, at the Opening Ceremony of the Second International Congress of Polarography on 24th August, 1959.

Plessey Sales Convention

ADDRESSING a two-day Sales Convention of the Plessey Organisation which was held at The College of Aeronautics, Cranfield, Bedfordshire, Mr. A. G. Clark, chairman of The Plessey Company Limited, reviewed the progress and development of the Company since its formation 40 years ago.

"In that time," said Mr. Clark, "Plessey has extended its interests to an increasing number of industrial fields of a diverse nature. Today, The Plessey Organisation has 54 manufacturing units located in 28 factories and research establishments, supported by an international sales organisation with world-wide coverage."

Mr. E. K. Cole examining the certificate presented to him by the President of the British Institution of Radio Engineers

Comprehensive surveys of the work of each product group were introduced by the specialist directors concerned, Mr. M. W. Clark, Chairman of the Convention (Electronic and Equipment Group), Mr. E. J. Earnshaw (Aircraft and Atomic Energy Group), Mr. J. A. Clark (Components Group), and Mr. A. E. Underwood (Swindon Group). Other directors to address the Convention were Mr. Bedford Attwood, who reviewed the activities of Plessey International Limited, the company responsible for sales overseas of products made by The Plessey Organisation, and Mr. J. F. Mallabar, on "Finance".

Talks were also given on the subjects of "Personnel" and "Commercial Co-ordination", by Mr. A. M. Brown and Mr. C. D. H. Webb, respectively, executive directors.

A feature of the Convention was the widespread use, in support of each address, of electronic aids, such as closed circuit television and stereophonic sound and animated display charts.

Brit. I.R.E. 1959 Convention

AT this year's Brit. I.R.E. Convention, held at Cambridge University, Dr. V. Zworykin and Mr. E. K. Cole attended a banquet, held in their honour in Downing College, to celebrate their election to honorary membership. In the 34 years of the Institution's history, there have been 15 honorary members elected but this is the first time two such elections have occurred in the same year.

Cambridge Instrument: Enlarged Headquarters

WITH the acquisition of the lease of No. 14 Grosvenor Place, the Cambridge Instrument Company's headquarters have been extended. This will permit enlarged sales facilities and better attention to customers and correspondents. The official address will remain 13 Grosvenor Place.

The Publicity and Accounts Departments, which in recent months have had separate premises, have moved back to headquarters, and the premises at 60 Buckingham Palace Road have been vacated. No further correspondence should be addressed there.

Changes of Address

A.N.T.E.X. are now at: 7/8 Idol Lane, London, E.C.3.

British Insulated Callender's Cables Ltd., Lincoln Branch Office is now at: Holmes Road, Lincoln.

Evershed and Vignoles Ltd., Scottish Area Office is now at: 30 Rutland Square, Edinburgh, 1. Telephone No. Fountainbridge 3056.

Foster Instrument Co., Birmingham Office is now at: 63 Blucher Street, Holloway Head, Birmingham, 1. Telephone No. Midland 4114.

Light Soldering Developments Ltd. are now at: 28 Sydenham Road, Croydon, Surrey.

Parkinson Cowan Industrial Products are now at: Dolphin Works, Fitzalan Street, Kennington Road, London, S.E.11.

Royston Instruments Ltd. are now at: Canada Road, Oyster Lane, Byfleet, Surrey. Telephone No. Byfleet 4356.

Smiths Aviation Division is now at: Kelvin House, Wembley Park Drive, Wembley, Middx. Telephone No. WEMbley 8888.

Square D Ltd. A new Bristol Branch has been opened at: 46 Queen Sq., Bristol, 1. Telephone No. Bristol 20995. Mr. G. W. T. Hall has been appointed branch manager.

Change of Name

MERCIA ENTERPRISES LTD. have changed their name to Coventry Controls Ltd. The address is Godiva House, Allesley Old Road, Coventry.

Ekco Electronics in Italy

EKCO ELECTRONICS LTD. announce the formation of a new company in Italy (to be known as Ekco Nucleare Italiana, s.r.l.) in association with Ing. Silvio Garrone, s.r.l. The Company, which will deal with the Italian market, will facilitate nuclear instrumentation in the fields of atomic reactors, industrial instrumentation and the sale of nucleonic and research development instruments.

Ing. Silvio Garrone is managing director of the new company, which has a head office at Via Dei Malvezzi, Rome, and a further office at Corso Matteotti 2, Milan.

Scottish Cables Link-up with BICC Group

BRITISH INSULATED CALLENDER'S CABLES LTD. has made offers to acquire the whole of the Issued Capital of Scottish Cables Ltd. on an exchange of shares basis.

High Speed Computers

NATIONAL RESEARCH DEVELOPMENT CORPORATION have decided to support two British manufacturers, Ferranti Ltd. and E.M.I. Electronics Ltd., in further development work on advanced high speed computers. This decision will result in the emergence as rapidly as possible of two substantially different machines which will exploit the advanced techniques becoming available in the two companies and, between them, will help to keep the British computer industry fully competitive in world markets.

Texas Instruments: European Distributors

TEXAS INSTRUMENTS have formed a new sales team to expand their coverage of Europe.

Distributors have already been appointed in Denmark, France, Sweden and Switzerland.

DENMARK. Ditz Schweitzer, Bredgade 37, Copenhagan.

FRANCE. France Nucléaire Electronique, 13 Rue Cimarasa, Paris, 16.

SWEDEN. A. B. Gösta Bäckstrom, Ehrensvärdsgatan 1-3, Stockholm.

SWITZERLAND. Fabrimex A.G. Zurich, Kreuzstrasse, 36, Zurich, 32.

Besson and Partner Ltd.

OWING to reasons beyond the control of both companies it has been mutually and amicably agreed that Westool Limited will cease to act as selling agents for A. P. Besson and Partner Limited as from 1st August, 1959.

BISRA "Open Days"—London Group Laboratories

THE British Iron and Steel Research Association is planning two Open Days at their laboratories at Battersea Park Road, London, S.W.1, on Thursday and Friday, 22nd and 23rd October.

The Open Days will provide an opportunity for showing the current and continuing work of BISRA's London Group Laboratories, which besides the Battersea premises include part of the Ironmaking Division housed at the Imperial College of Science at South Kensington. The Battersea premises house the laboratories of the Association's Plant Engineering and Energy Division, and the Departments of Physics, Chemistry and Operational Research.

In the Plant Engineering and Energy Division's laboratories, the Electrical Engineering Section will display the extensive work being done on electrical control and recording; this will include, for example, the "Tallimarker" apparatus, one of the latest developments in information handling. The Civil Engineering Section will be showing work on the design and testing of girder and gantry structures, whilst the Mechanical Engineering Section will have on display a number of projects relating to the handling of bulk materials, and hydraulic and other control systems for steelworks' plant. The recently-formed Energy Section of the Division will mount displays relating to its recent inquiry into the fuel consumption of the industry.

In the Physics Department, the new Automation Section will be showing one of its first projects, involving the automatic deseaming of billets. The Instrument Section will highlight several projects in support of the premise that instruments are the first step towards automation, while the Metal Physics Section will show something of the continuing investigations into the problem of combined creep and fatigue.

The Chemistry Department will be highlighting the work of its Physical Chemistry, Corrosion and Refractories Sections.

The Operational Research Department, besides showing the work of its Computer Application Section and Human Factors Section (which latter includes ergomomics) proposes to highlight the work of its Operational Investigation Section, which has already carried out studies on behalf of a number of firms throughout industry.

A special display of one of the most important projects of BISRA's Ironmaking Division is being prepared, to illustrate the principle of the recently-developed "SCICE" (Stationary Charge In Controlled Environment) apparatus.

A general invitation is extended to all industrialists and others interested in the engineering and technical problems which concern the iron and steel industry. The Information Officer of BISRA at 11 Park Lane, London, W.1, will be glad to hear from those wishing to attend.

I.S.A. Meetings—1960

THE Instrument Society of America has trebled its programme of instrument-automation conferences and exhibits for next year and, in addition to its conference and exhibit schedule, it is conducting five symposia and is sponsoring, or participating with other societies in two other major technical meetings. The schedule for next year includes:

March 9-11: ISA Temperature Measurement Symposium, Deshler Hilton Hotel, Columbus, Ohio. Contact: Director of Technical and Educational Services, Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa.

April 3-8: Sixth Nuclear Congress, New York City. Sponsor: Engineers Joint Council, ISA co-operating. Contact: Director of Technical and Educational Services, Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa.

April 5-7: Third National Chemical & Petroleum Instrumentation Symposium, Rochester, N.Y. Contact: Director of Technical and Educational Services, Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa.

May 2-5: Sixth National Flight Test Symposium, San Diego, California. Contact: Director of Technical and Educational Services, Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa.

May 9-11: Third National ISA Power Instrumentation Symposium, San Francisco, California. Contact: Director of Technical and Educational Services, Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa.

May 9-13: ISA Instrument-Automation Conference and Exhibit for San Francisco, California, Brooks Hall. Contact: William H. Kushnick, Executive Director, Instrument Society of America, 313 Sixth Avenue, Pittsburg 22, Pa.

May (date to be announced): Ninth National Telemetering Conference, West Coast. Sponsor: ISA with American Institute of Electrical Engineers; American Rocket Society and Institute of Aeronautical Sciences co-operating. Contact: Director of Technical and Educational Services, Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa.

June 1-3: Sixth Annual Instrumental Methods of Analysis Symposium, Montreal, Canada. Contact: Director of Technical and Educational Services, Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa.

September 26-30: ISA Instrument-Automation Conference and Exhibit and 15th Annual Meeting, New York Coliseum, New York City. Contact: William H. Kushnick, Executive Director, Instrument Society of America, 313 Sixth Avenue, Pittsburgh 22, Pa.

I.F.A.C. Annual I.S.A. Conference

ARRANGEMENTS have been made by the International Federation for Automatic Control for presentations by eight overseas authorities at sessions of the 14th Annual Instrument-Automation Conference and Exhibit of the Instrument Society of America in Chicago, 22nd September.

Dr. C. J. D. M. Verhagen, Professor-Director at the Technological University of Delft, The Netherlands, will be the session's chairman. Speakers from Japan, Russia, Czechoslovakia, Great Britain, France, Germany (2), and Sweden will participate in the conference and their papers will discuss recent developments in these countries in applications and design of specific types of equipment for automatic control.

The programme arranged by the federation for the ISA Conference includes:

"The Ringtorductor—a torque gauge, without sliprings, for industrial measurement and control", by Orvar Dahle, of Allmanna Svenska Elektriska Aktiebolaget, Sweden; "A pulsating gas flowmeter and its applications to flow control", by Dr. T. Isobe, of the Instrumentation Section of the University of Tokyo; "Some questions concerning the construction of magnetic instruments for gas analysis", by D. I. Ageikin, candidate of technical sciences, Institute of Automatics and Telemechanics of the USSR Academy of Sciences; "Dynamic behaviour of instruments for gas analysis in connection with automatic control", by Dr. Erwin Leher, Badische Anilin- & Soda-fabrik, Ludwigshafen am Rhein; "Force balance or motion balance in the design and application of electronic differential pressure transmitters", by Dr. Heinz Kronmuller, Siemens & Halske, A.G., Karlsruhe; "Electronic generators of random processes for the simulation of fluctuations in automatic control", by I. M. Ullrich, Institute of Information Theory and Automation of the Czechoslovak Academy of Sciences; and "Developments in automatic data handling", by C. A. Laws, D. W. Hobbs and P. F. Sutherby, Elliott Bros., London.

Foresight Productions Ltd.: Change of Name

THE name of this company is now Gothic Electronic Industries Ltd.

Atomic Energy Establishment, Winfrith

THE Atomic Energy Establishment at Winfrith is the second major establishment of the A.E.A. Research Group, and is being built to meet the needs of a reactor research programme. It has been set up to study new ideas and provide basic design data for application to power generation, and the physics and engineering development work connected with reactor experiments and small prototype systems will be undertaken here. There is space for at least six experimental reactors at A.E.E., Winfrith.

The establishment will maintain a close working relationship with Harwell where the research and basic development work on the chemical, metallurgical and nuclear physics aspects will still be centred.

The first reactor experiment to be undertaken at Winfrith will be that provided for under the O.E.E.C. agreement for research in the high temperature gas cooled reactor field. It is known as the DRAGON Project.

Air Trainers Link Process Simulator-Computer

DUE to the increasing importance of automatic control in petroleum processing, BP's Refineries and Technical Department have ordered from Air Trainers Link Ltd. an electronic analogue computer/process simulator.

This machine, known as CERES (Control Engineering Research Electronic Simulator) will be built at Aylesbury to BP specifications, and used at Longbow House, in London, to simulate conditions in various fields of refining operations so that the most suitable automatic control systems and efficient plant designs can be studied and developed. It will also be used to investigate such problems as plant economics and stress and vibration analysis.

When set up as a simulator CERES will be used to reproduce typical or exceptional situations in controlled refining processes. Plant operators may therefore be trained to deal with a range of conditions which it would be impractical to arrange at the refinery itself. New processes may be demonstrated before the completion of the plant.

The computer is based on 0·1% accuracy in all elements. This may often be higher than the accuracy of the input data but will ensure a range of simulation of not less than four decades.

Forty-eight of the new d.c. amplifiers developed by Air Trainers Link Ltd. will be provided and no less than 92 coefficient potentiometers. These latter will be set with the aid of a digital voltmeter, but an automatic setting mechanism may be added later.

Two types of servo-multiplier are provided. One has a very fast response and the other, though much slower, is suitable for long-term integration. The latter unit will be used in the simulation of processes with time constants of many hours. Both types will generate non-linear functions if required.

Other elements included are 10-segment electronic function generators, a very low frequency oscillator giving a wide variety of waveforms, and a small double-beam monitor oscilloscope.

Two patch panels are provided which have removable plug boards giving pre-patching facilities.

The whole equipment, including power supplies, will be housed in six standard 19-in. racks.

PUBLICATIONS RECEIVED

British Iron and Steel Research Association, Annual Report, 1958
Among the projects in B.I.S.R.A.s current research are the following: Radar used to study the stockline contour in blast furnaces; closed circuit television used to measure the dimensions of hot forging stock, moving rod, etc.; development of the process of lacquering strip by electrophoresis; development of a disappearing filament pyrometer to measure accurately the last 100°C rise in ingot temperature.

Bulletin of the Provisional Computation Centre (4-5), April, 1959
Third meeting of the Preparatory Committee of the International Computation Centre.
Working Party on processing of statistical data.

Dawe Digest, 2, (1), March, 1959.
Investigation of cavitation on high-speed propellers.
Two new oscillators, K. CIEPLAK

Dawe Digest, 2, (2), June, 1959.
Ultrasonic cleaning at Harwell.
New transistorised frequency meter, B. J. WHITE.

Expansion (4).
German re-unification.
An electromagnetic separator.

Marconi Instrumentation, 7, (2), June, 1959.
General purpose oscilloscope Type TF 1330, L. D. KREPS, D. C. JONES, J. D. JULIAN and J. K. MOORE.
Circuit magnification meter TF 1245, S. G. PRITT.
Test gear for test gear, J. F. GOLDING.

Mullard Technical Communications, 4, (38), April, 1959.
The design of a standard block for a digital computing system, R. J. MILES.

Mullard Technical Communications, 4, (39), May, 1959.
Multi-triode flywheel synchronising circuit, M. C. GANDER and P. L. MOTHERSOLE.

Platinum Metals Review, 3, (3), July, 1959.
The platinum resistance thermometer, R. PRICE.

Perkin-Elmer Instrument News, 10, (2), Winter, 1959.
Infra-red spectrophotometer, Model 221.

Saro Progress, (1), 1959.
Foil strain gauges.

Solartron 1958, Annual Report.

Water Pollution Research 1958, Annual Report.

MANUFACTURERS' PUBLICATIONS

Flowrators

An eighty-page catalogue gives details of the Flowrator range of standardised scale glass tube variable area flow indicators. Complete specifications are given of nine types of standard Flowrators, with their prices. Flow calibration curves and conversion formulae enable the flow of any liquid through any Flowrator to be determined, and a section contains recommended materials of construction of Flowrators for use with corrosive fluids.

Circle **45** *for further details.*

CO_2 Meter

This meter measures automatically the CO_2 content of flue gases. Catalogue No. 180 describes the principle of operation and lists the components of the complete installation.

Circle **46** *for further details.*

Gordon Products

The products listed briefly in Catalogue No. 103 include gas analysis equipment, temperature measuring instruments and controllers, feedwater controllers, and automatic combustion controllers.

Circle **47** *for further details.*

Electrolytic Conductivity

Electrolytic conductivity recording and indicating instruments are described in Leaflet RIC3. Leaflet MC1 gives details of a portable electrolytic conductivity measuring bridge.

Circle **48** *for further details.*

Thermometers

Comprehensive specifications are given for a range of thermometers for specialised applications.

Circle **49** *for further details.*

Carbon Brushes

A 24-page booklet gives details of the manufacture, construction and mounting of brushes, the grades available, and accessories available for brush mounting and maintenance.

Circle **50** *for further details.*

Unit Seals

Advantages, construction, operation and specifications are given for the Morganite unit seal and the Morganite positive drive unit seal. These seals are primarily intended for low pressure pumps and similar appliances.

Circle **51** *for further details.*

Metric Series Rotameters

Details are given of a range of interchangeable standardised Rotameters.

Circle **52** *for further details.*

Permanent Magnets

The dimensions and holding forces of a range of holding and lifting permanent magnets of Alcomax and Alnico alloys are listed.

Circle **53** *for further details.*

Smoke Densitometer

A smoke densitometer and alarm which complies with British Standards is described in Leaflet Series SME.2.

Circle **54** *for further details.*

Cambridge Instruments

A summary of the complete range of Cambridge Instruments is given in List E.4.

Circle **55** *for further details.*

Dynamic Analysis

This 16-page brochure gives details of instrumentation for the design, analysis and production testing of electronic, electrical, mechanical, hydraulic and pneumatic systems.

Circle **56** *for further details.*

Weston Electrical Instruments

This comprehensive catalogue covers the range of instruments manufactured by the company subdivided under the following headings: panel instruments; switchboard instruments; portable instruments; laboratory standards; current transformers; miscellaneous instruments.

Circle **57** *for further details.*

Transistorised Instruments

Leaflet 615 describes a transistor frequency meter designed for the measurement of frequencies between 10 c/s and 30 kc/s.

Leaflet 421 describes a transistorised oscillator covering the range 20 c/s to 20 kc/s.

Circle **58** *for further details.*

Demonstration "Megger" Test Sets

"Megger" test sets in specially adapted form to enable the operational functions and details of construction and maintenance to be studied are described. These instruments are intended especially for educational institutions.

Circle **59** *for further details.*

Impedance Bridge

Features and specifications of the instrument are given in the leaflet.

Circle **60** *for further details.*

Lighting Equipment

The booklet gives details of optical and lighting equipment for visual inspection.

Circle **61** *for further details.*

Laboratory Equipment

Leaflets describe a titration stand, a shaker, and a glassware drying cabinet.

Circle **62** *for further details.*

Solenoid, servo-operated and air-operated valves

Diagrams and specifications are given of the company's range of valve units for industrial applications.

Circle **63** *for further details.*

Polypenco Nylon

The advantages and uses of this material are enumerated and lists give the shapes and sizes available.

Circle **64** *for further details.*

Space "30" Analogue Computer

The data sheet lists applications of the computer. The operational amplifiers, coefficient potentiometers, diode function generators, servo multipliers and patch panel are described briefly, and details are given of computer control.

Circle **65** *for further details.*

Oscilloscopes

Two leaflets describe respectively an infinite persistence oscilloscope which uses a "Memotron" tube, and a double-beam oscilloscope.

Circle **66** *for further details.*

Precision Tube Developments

Among the developments described are tubes in special metal, helically convoluted flexible tubing, annular convoluted tubes for flexible joints, helically gilled tubing, special thin walled tubing, multibore tubing and Bourdon tubing.

Circle **67** *for further details.*

Transfer Function Analysers

These systems have been designed to provide an accurate means of testing servomechanisms and control gear. Their theory and application are described.

Circle **68** *for further details.*

Level Recorder

Publication 1009 is the spare-parts list for this instrument.

Circle **69** *for further details.*

Power Cylinder

The Mark 4 air-operated power cylinder with position-control unit is used in air-operated automatic-control systems. The position-control unit employs the force-balance principle.

Circle **70** *for further details.*

Electronic Amplifiers

Type M amplifier is for servo-motor operation, Type R for relay operation and Type G for galvanometer operation.

Circle **71** *for further details.*

SOCIETY OF INSTRUMENT TECHNOLOGY

Bristol Section

THE paper at the March meeting was given by the Section Chairman, Mr. H. B. Palmer, of the National Smelting Co. Ltd. The title of the paper was "A process and its instrumentation", the process being that of sulphuric acid production.

Mr. Palmer began by discussing the various industrial methods of sulphuric acid production. He then described step by step the operation of the contact process acid plant at the Avonmouth works of The National Smelting Co. Ltd. Next he discussed the instrumentation needs of the plant and showed the instruments actually at Avonmouth. Of particular interest were the methods of temperature control, both during starting up and running of the convertors in which the SO_2 is oxidised to SO_3. Mr. Palmer concluded by discussing the maintenance problem of instruments associated with the plant.

It was intended that as a follow-up to this lecture a visit to the Avonmouth works in April would enable members to see the actual plant described by Mr. Palmer, as well as other aspects of zinc smelting and chemical manufacture.

A visit was made to the G.P.O.'s Bristol Trunk Dialling Telephone Exchange. Here members were able to see the much-publicised GRACE in addition to the many other interesting details of an automatic telephone exchange.

Manchester Section

THE lecture given by Mr. Bennett on 10th March, on electromagnetic flowmeters, covered both theory and application. The Faraday principle was employed many years ago to measure the flow rate of the river Thames using the earth's magnetic field. Ten years ago the Dutch Government was interested in the flow measurement of slurries and sludges with a solids content of 18-20%, in connection with land reclamation. The first flowmeter tried had a permanent magnet field and produced a d.c. e.m.f. Selective chemical attack on the electrodes led to a changeover to an a.c. field as used now. The e.m.f. is proportional to the distance between electrodes, the velocity and the field strength. There is a steady "shorted turn effect" e.m.f. which causes some difficulty in the measurement of small flows. The meter indicates flow rate and is independent of velocity profile in the pipe. As the output is a summation over the area of pipe, uneven flow is measured correctly provided that the magnetic field is homogeneous. The usual field strength is several hundred gauss. The larger the bore the smaller the field strength required. The largest flowmeter made is about 6 ft diameter and the smallest 3 mm, below which construction is mechanically difficult. The field coils are designed and shaped to give a homogeneous field and the iron circuit is only added to reduce the influence of external fields. The electrode area must be small to avoid short circuiting the passing "discs" of fluid and are usually between 1 and 2 mm across. For transient response under $\frac{1}{15}$ sec, point electrodes must be used. Several problems are involved in the meter construction, it must be lined with an insulating material and the electrodes must be sealed to the lining. The usual full scale e.m.f. is between 0·5 and 0·8 mV. The fluid conductance should not be less than 100 micromho/cm³ so that varying conductance has no significant effect on the reading. The amplifier must have a high input impedance and linear output. The flowmeter is unaffected by bends in the pipe, flow profile, temperature, pressure and viscosity.

As the electromagnetic flowmeter is independent of viscosity it can be connected in series with a viscosity sensitive flowmeter and viscosity can be measured. When used in conjunction with a conductivity meter % solids content can be measured. If, as usually happens, the material conductivities are not constant, changes must be compensated. Blood flow has been measured by providing a magnetic field across an artery and inserting needles to the correct spacing. Cement flow is measured commercially. The amplifier unit should not be more than 30 ft from the detecting element. The electromagnetic flowmeter measures velocity of flow and indicates volume flow rate by the introduction of a pipe area factor. Entrained air simply increases the impedance and only affects the readings if in the form of large voids in the fluid. Build-up of residue on the walls of the flowmeter does not affect the reading if there is no change of conductivity. Any difference in conductivity alters the shorted turn effect and causes a change of reading. As a result of build-up the fluid velocity increases for the same volume rate. As the meter summates the incremental velocities across the tube the zero velocities in the build-up balance the increases in the fluid. High viscosity materials can be measured, in fact, any materials which can be pumped, e.g., toothpaste. A 3 in. electromagnetic flowmeter was exhibited.

The meeting was well attended and a lively discussion followed.

On 12th May the Manchester Section had a very full programme, commencing with the Annual Meeting. Satisfaction was expressed at the renewed vigour of the meetings in their new quarters and proposals for further amenities were discussed. The Chairman expressed the meeting's regrets that Mr. E. Hodgson was not free to be re-elected secretary, and that application of the new rules caused the retirement from the committee of several members of exceptional experience. Mr. T. Jackman was elected as Hon. Secretary and Hon. Treasurer.

The President of the Society, Mr. J. F. Coales, paying a surprise visit, pleased the members with his concise survey of affairs engaging the council's attention. Progress in educational matters and in the numbers and status of membership was noted with great interest. The evening concluded with a talk from Mr. C. K. Massey on "Temperature measurements with resistance thermometers", giving an outline of types of thermometers, their manufacture, and typical applications. Circuits for use with different measuring instruments were illustrated, together with means of overcoming effects of supply voltage fluctuations. During a lively discussion problems such as the distinction between Class A and B elements, and the competitive claims of resistance thermometers and thermocouples were freely debated.

Midland Section

ON the 19th May the Midland Section held a joint meeting with the Birmingham Productivity Association at the College of Technology under the chairmanship of Mr. C. E. T. Cridland, M.I.E.E., past President of the Scientific Instrument Manufacturers' Association. The speakers were Mr. R. S. Medlock, B.Sc., A.R.I.C., A.M.I.Mech.E., A.M.I.E.E., Research Director of George Kent Ltd., and Mr. D. Boxall, A.I.M., Liaison Officer of the British Non-Ferrous Metals Research Association.

Mr. Medlock spoke first upon the subject of "Instruments which are standard and available" and his remarks were supported by several simple but effective demonstrations, and also slides. He had also provided a means of getting the reaction of a considerable proportion of the

audience, there being two-position switches which many of those present could place in a YES or NO position in answer to questions which Mr. Medlock put, the overall reaction being displayed on a large dial indicator as a percentage of the total.

Mr. Medlock suggested that his subject could be divided into three main parts—primary measurement, presentation and automatic control. Several slides were shown to illustrate the available apparatus, typical installations and the part played in productivity. The advantages as well as some disadvantages were listed, and the benefits arising from the use of instruments mentioned. Several instances were given of savings and improvements resulting from the use of instrumentation. The demonstrations included one of the automatic control of a gas flame, such as might be used for automatic glass blowing, from a thermocouple at the base of the flame. By comparison with an uncontrolled burner alongside it was shown how a consistent flame was obtained with variations in air/gas mixture. Another effective demonstration was automatic control of heat input to keep some water in a flask just on the boil, this being done from the pressure in the flask, above the water. One of Mr. Medlock's arguments for complete and effective instrumentation and control referred to the disaster at Windscale, which resulted from insufficient instrumentation.

The talk given by Mr. Boxall was upon "Instruments that are needed but not available", and he also used slides to illustrate the lecture. It was explained that a pressing reason for more instrumentation was the greatly increased productivity of modern plant. Instruments for "in-line" inspection became essential, and these should use non-destructive techniques where possible, such as beta and gamma gauges, or more recently the supposedly superior X-ray gauges. Error actuated control of the machine was desirable, where this can be arranged. Eddy current and ultrasonic methods of non-destructive testing for flaws and cracks in billets and pressed parts were mentioned and illustrated. Physical methods of analysing metals were now being used because of their greater speed as compared with the older chemical methods and the direct reading spectrometer was shown as an example, and X-ray fluorescence analysis also mentioned. Mr. Boxall referred to several instruments and measurements which were not at present possible but which would greatly assist productivity and these included the automatic control of melting furnaces from molten metal temperature, and of extrusion presses from the temperature of the extruded metal.

The Chairman invited questions and several were asked which the lecturers dealt with ably.

The Midland Section held their final meeting of the 1958/59 Session on the 10th April, this being their thirteenth Annual General Meeting.

The election of officers for 1959/60 Session took place, Mr. E. R. O'Dell being the new Chairman, in place of Mr. H. J. Smith who has occupied that office for the past two years to the great benefit of the Section. Another stalwart supporter who now stands down after many years' service to the Section as Secretary, Chairman and Committee Member is Mr. A. J. Stubbs.

Mr. D. Smith, in his report as Secretary, mentioned that the Section Membership now stood at 210, and that the average attendance at the seven meetings was 53. A very successful evening visit to the works of Midland Tar Distillers had taken place and also a joint meeting with the Birmingham Productivity Association. The Chairman, Mr. H. J. Smith, in his remarks gave news of the activities of the Council, particularly as to the formation of new Local Sections. He stated that the resolution of regions throughout the country was being undertaken, and that under this arrangement there would possibly be a requirement for the formation of additional local Sections in Midland towns. The matter of the compliance of the Midland Section with the new Local Section Rules, annexed to the Memorandum and Articles of Association, was also dealt with.

To conclude the evening two films were shown, the first "Operation Push Button", which dealt with applications of air motors, and the second "Panorama", a topical I.C.I. film.

ON Wednesday, 10th June, the Section visited the Standard Motor Company in the morning, where they were shown the production of Triumph Herald cars in some detail, from the initial assembly of the basic sections of the car, through the semi-automatic painting area to the motor assembly and final despatch. Great interest was shown and Messrs. Standards then provided lunch for the party of 30, plus coach driver.

Data Processing Section

A VISIT to The National Gas Turbine Establishment at Pyestock took place on 30th May, and was enjoyed by 24 members who came along. A coach transported the majority of members from Victoria Station to Pyestock, with a stop at Virginia Water for lunch. The coach party were then joined at the Establishment by a further seven visitors, and the party proceeded into the Establishment and were met by Mr. L. Airey who recently delivered a paper for the Section. After an introductory talk by Mr. Airey, the party was split into three groups and conducted round the extensive Establishment.

Groups were shown the two existing Compressor Stations erected to supply the huge quantities of air required for testing modern gas turbine engines, and were shown a third larger Compressor House in the course of completion. They also saw some of the engine test cells, and were fortunate to be able to enter one of the altitude chambers in which tests are conducted. Access was made to the test cell control room, and the visit finished in the Computer Room in which an account was given of the use of the computer in processing data immediately it becomes available from the instrumentation of each test cell. A demonstration of the working of the computer and the print-out of information was also given.

Mr. Coales thanked Mr. Airey on behalf of the Society for a most interesting visit, and the party then proceeded into Farnborough for tea before returning, either by coach or private means, to London.

East Midland Section

THE final meeting of the session was the A.G.M. in April, this being held at Loughborough, which is roughly the centre of our area. We had the honour on this occasion of entertaining the president of the Society, Mr. J. F. Coales, and the meeting was well attended.

In order to establish a rotation of committee membership, two members, Mr. Emmerson and Mr. Gardiner, have retired after two years' service, and the vacancies have been filled by Mr. J. H. Littlewood (Derby) and Mr. F. J. Pay (Nottingham). The Section is indebted to Messrs. Emmerson and Gardiner for their services during their term of office. The committee thus remains representative of each of the centres within our area, and in a Section of this type this is an invaluable asset in the variety of contacts for obtaining speakers and arranging meeting accommodation.

The membership of the Section has now reached 50, representing a growth factor of four in under two years of existence, and owing to the increasing pressure of work, the office of honorary programme secretary was created at the A.G.M. It was not, of course, constitutionally possible to fill this office at the same time, but the committee hopes to co-opt one of its members for this purpose during the 1959/60 session, and as a result it is hoped to furnish members with a synopsis of each paper seven days in advance of the meeting.

The additional office of immediate past chairman, also unfilled this year, was created.

Professor J. E. Parton remains in the chair.

The meeting was asked to vote in favour of each item of our proposed programme for 1959/60 in order that the popularity of each subject and its location could be judged.

For the coming session, it is proposed that subjects should be "away" rather than "at home", and the voting obtained at the A.G.M. would seem to indicate that this is possibly the better policy. We have been unfortunate in weather conditions during the recent session, practically every meeting having been accompanied by fog, snow or ice, or a combination of all three, and in order to attend three out of every four meetings it is necessary to travel between 10 and 30 miles. We can only hope for better luck next year.

To close the session's activities, the president gave an address on "Automatic Control in Russia", followed by an illustrated talk on Moscow.

The tentative programme for 1959/60 includes the following:—

"Making and Using Transistors"
"The Atomic Clock"
"Measuring Vibration"
"Instrument Research at Stewarts & Lloyds"
"Medical Instrumentation"
"Uranium Prospecting".

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PERSONALITIES

British Driver-Harris Directors

The board of directors of British Driver-Harris Co. Ltd. announce the appointment of two new directors.

Mr. H. E. E. Thomas, for several years sales manager, has been made commercial director.

Mr. E. Shuttleworth, technical adviser to the president of Driver-Harris, N.J., has also been appointed a director of the British company.

Fischer & Porter Appointments

Mr. Frank N. Yates, formerly Northern representative for Sunvic Controls Ltd., is now sales manager for Fischer and Porter Ltd., and will be based at the Head Office in Cumberland.

Mr. B. A. Worswick, B.Sc.(Hons.), A.Inst.P., formerly chief development engineer for Bailey Meters & Controls Ltd., has been appointed development manager at the Fischer & Porter factory in Cumberland. Mr. Worswick has just returned from a month's visit to the Fischer & Porter Co. plant in Pennsylvania, U.S.A.

Mr. David Y. Smith has been appointed Northern technical representative. His address is: "Gavea", Burton Drive, Poynton, Cheshire. Telephone: Poynton 3779.

Mr. Kenneth W. Gilbert has been appointed Midland technical representative. His address is: 333 Highters Heath Lane, Hollywood, Birmingham.

Mr. G. M. E. Williams

Mr. G. M. E. Williams, B.Sc., A.M.I.E.E., has been appointed head of the Department of Production Technology and Control Engineering in the Northampton College, London.

This department combines the work formerly undertaken by the College in production engineering and instrument technology. It will be expanded to provide a broader basis for existing advanced courses and extend post-graduate and refresher work and research in this rapidly changing field. The department is providing sandwich courses in production engineering and in instrument and control engineering for Diplomas in Technology, and in the latter case the course is the only one so far approved by the Hives Council.

Mr. Williams is 41, with experience in industry and the Government Scientific Service, and was, until recently, with Combined Technical Services Ltd. of the P.-E. Group. He is also in private practice as a consulting engineer.

Mr. G. T. P. Gardner

Mr. G. T. P. Gardner has been appointed sales director of B.M.B. (Sales) Limited, Crawley, Sussex, who are the sole selling agents for British Manufactured Bearings Co. Ltd., manufacturers of miniature precision bearings, steel balls and sapphire and diamond styli; also for John Bass Ltd., clean air plant, pressurised assembly cabinets, etc.; Pathfinder Ltd., dry air equipment.

Mr. Gardner joined B.M.B. in 1949 as secretary, he subsequently became works manager and is currently works director.

Principal Officers of the I.P.E., 1959/60

The Council of the Institution of Production Engineers is pleased to announce that Mr. G. Ronald Pryor, M.I.Prod.E., has been elected president of the Institution for the year 1959/60.

Mr. Pryor has served on the Council continuously since 1945, and was chairman from 1954/56. In 1956 he led the U.K. delegation to the Delft Conference, initiated by the Institution, on Teaching of Production Engineering at University Level, and in 1958, jointly with Mr. J. E. Hill, he headed the Institution's delegation to Poland.

Mr. H. W. Bowen, O.B.E., M.I.Prod.E., the present chairman of Council, has been re-elected for a further year of office. He has taken a leading part in the activities and development of the Institution since he became a member in 1934.

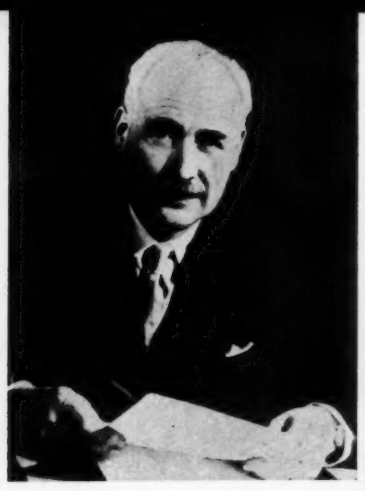
Mr. R. H. Turner, M.A.(Cantab.), M.I.Prod.E., has been re-elected for a further year of office as vice-chairman of Council. Mr. Turner is director and works manager of Metropolitan-Vickers Electrical Co. Ltd., Manchester.

Mr. W. A. G. Brian

The appointment is announced of Mr. W. A. G. Brian as secretary/accountant of Marconi Instruments Ltd.

Mr. Brian joined Marconi Instruments in 1946 and has served in all sections of the Accounts Department. From 1949 to 1955, as deputy to the then assistant accountant, he gained valuable experience in the Company's final accounts, and also acquired a wide knowledge of the work of the Company; in 1956 he became assistant accountant.

Mr. Brian succeeds Mr. C. Stanier, A.C.I.S., F.I.A.C., who retires after nearly 30 years in the service of the Marconi Companies.



Mr. L. S. Yoxall

Mr. L. S. Yoxall

Mr. Laurence S. Yoxall, managing director of Foxboro-Yoxall Limited, has joined the board of directors of the Foxboro Company, Foxboro, Massachusetts, U.S.A.

In addition, therefore, to controlling and directing the activities of the English Company, Mr. Yoxall now becomes directly concerned with the operations of The Foxboro Company, U.S.A.; The Foxboro Company Limited, Canada; the new plant being built for Foxboro (Nederland) N.V., Holland, and the Foxboro interests in Japan.

Square D Appointments

Square D Limited announce the appointment of Mr. R. G. Camp as their headquarters sales manager. Mr. Camp operates from the Company's new headquarters located at Cheney Manor, Swindon. He has hitherto been the Company's Northern Area manager. Mr. Camp is one of the original team which founded Square D Limited in this country.

The vacancy of Northern Area manager has been filled by Mr. K. W. Liller. Mr. Liller is located at the Northern Area Office at 3 Hawthorn Lane, Wilmslow, Cheshire.

Delta Technical Services Ltd.

Mr. S. A. E. Barrow has relinquished his position with Stone and Webster Engineering Ltd. to join the board of Delta Technical Services Ltd. Mr. Barrow has spent some 19 years in the electronic, electrical and pneumatic instrument industries in both the manufacturing and constructional fields.

Mr. L. A. Woodhead

Mr. L. A. Woodhead, managing director of Cossor Instruments Ltd., was recently inaugurated as the new S.I.M.A. president.

Texas Instruments' Appointments

Dr. J. T. Kendall has been appointed as general manager (marketing), replacing Mr. K. R. Simmonds who has resigned. Dr. John Powell has been promoted to the position of general manager (technical) vacated by Dr. Kendall.

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Dr. J. L. Miller

Dr. J. L. Miller

Dr. J. L. Miller, D.Eng., M.I.E.E., formerly chief engineer of British Insulated Callender's Cables Ltd., has been appointed a consultant engineer by Telephone Manufacturing Co. Ltd.

Dr. Miller will continue his associations with other industrial, engineering and research interests.

While with B.I.C.C., Dr. Miller was a director of some of the Group Companies, including British Telecommunications Research. Prior to that he was chief research engineer at Ferranti Ltd.

Some years ago Dr. Miller carried out research in the high-voltage field, on transmission, and in the light-current and electronic fields. He is the author of many papers and has been awarded the Sebastian de Ferranti and the Paris Exhibition Premia of the I.E.E. Dr. Miller is a past member of Council of the I.E.E., a past chairman of the N.W. Centre of the I.E.E., and a past chairman of the Radio Group of that Centre.

Mr. C. R. Wheeler

Mr. C. R. Wheeler, C.B.E., has been elected a director of Associated Electrical Industries Limited.

Mr. Wheeler is joint managing director of Guest Keen Iron & Steel Company Limited, chairman of B.I.S.C. (Ore) Limited, a director of Guest Keen & Nettlefolds Limited, George Wimpey & Company Limited, British Iron & Steel Corporation Limited, and other companies.

Mr. N. E. Rigler

E. K. Cole Ltd. announces the appointment of Mr. Nigel E. Rigler as assistant publicity manager.

Mr. Rigler's work at Ekco will cover electronics, nucleonics, heating and plastics, in addition to Ekco radio and television, and he will be responsible to Mr. John E. Furley, publicity manager.

Mr. D. G. Heywood

Hilger & Watts Ltd. have appointed a new representative whose area will be Yorkshire, Lancashire, Cheshire, and North Lincolnshire. He is Mr. D. G. Heywood, A.Met., 21 Kirkstall Road, Sheffield, 11; Tel. Sheffield 64226.

Mr. Heywood's particular province will be the firm's analytical instruments: spectrographs, polychromators, spectrophotometers, polarimeters, refractometers, absorptiometers, colorimeters, etc.

Retirement of Sperry Chairman

Mr. Arthur Hillier, O.B.E., chairman and managing director of Sperry Gyroscope Company Limited, retired at the end of July after over 43 years' service with the Company.

A gift cheque representing contributions from employees was presented to him at a short ceremony in the canteen of the Company's Brentford factory on Wednesday, 22nd July, the presentation being made by Mr. Robert Broadbent, supported by his fellow directors and the secretary, before a large audience of employees, which also included representatives from the Company's Bracknell, Feltham and Stonehouse (Glos.) establishments.

Mr. Hillier joined the Company in 1916 as assistant secretary, four years later being appointed secretary, and in 1922 became a director. In the 37 years since then he played the leading part in the expansion of the Company, being successively joint general manager (1929) general manager (1933), managing director (1934) and chairman and managing director (1938).

For his services, Arthur Hillier has received many tokens of recognition from the British and foreign governments, including the O.B.E., Commander in the Order of Oranje Nassau (Holland),Commendatore in the Order of Merit (Italy) and Officer of the Legion of Honour (France). He was High Sheriff of the County of Middlesex, 1956-57.

Mr. Robert Broadbent, M.I.Mech.E., M.I.P.E., M.I.I.A., who formally made the presentation to Mr. Hillier on 22nd July, was recently appointed a managing director; he joined the Company as works manager in 1943, shortly afterwards was appointed general manager and became a director of the Company in 1947.

BICC Board Changes

British Insulated Callender's Cables Company Limited announce that Mr. William Fraser, B.Sc.(Hons.)(Elect.Eng.), has been appointed a director of the Company.

Mr. W. G. Hendrey, M.I.E.E., who had been a director since 1938, retired recently.

Mr. A. M. Moat

Mr. A. M. Moat, aged 29, has been appointed commercial manager of Servomex Controls Ltd. Before joining Servomex he was with Cox & Co. (Watford) Ltd., and the United Steel Companies Ltd. Mr. Moat is an economics graduate of Caius College, Cambridge, and has been made recently a Member of the Institute of Cost and Works Accountants

Mr. A. M. Moat

Dr. C. B. Speedy

Dr. C. B. Speedy

Dr. C. B. Speedy, Ph.D., B.E.(Hons.), Assoc. A.I.E.E., has been appointed to the board of directors of Lion Electronic Developments Ltd. Dr. Speedy is a director of Gresham Developments Ltd., and in his new capacity will help to consolidate the close liaison which exists between the two companies, whereby the manufacturing facilities of Lion Electronic Developments Ltd. are used to implement the research, design and development activities of Gresham Developments Ltd.

Mr. R. L. Cogdale

Mr. Robert L. Cogdale has been appointed European resident technical representative of Marconi Instruments Ltd., and will shortly take up residence near Paris. The establishment of this post will lead to a greater co-ordination of sales activities in this area, and, in particular, will reinforce the company's position in the countries forming the European Common Market.

Mr. Cogdale, a senior member of the company's technical sales staff, joined Marconi Instruments in 1941.

Mr. I. H. Gordon

Mr. I. H. Gordon has been appointed assistant sales manager of Cambridge Instrument Company Ltd., at the company's head office in London. He will provide additional liaison between head office and the company's 10 branch offices, and will assist sales promotion generally.

Mr. H. A. Parrott

Mr. H. A. Parrott has taken up an appointment for special duties with the Cables Division of Siemens Edison Swan Ltd. He will be based at the company's office at 155 Charing Cross Road, London, W.C.2.

Mr. Parrott is well known for his contribution to the work of the Cable Makers' Association, with whom he has been for 34 years, the last 11 of which were as Secretary to the Rubber and Thermoplastic Cable Manufacturers' Association.

Mr. F. Duerden

Mr. F. Duerden, B.Sc.(Hons.), A.M.I.E.E., has been appointed manager of Bruce Peebles & Co. Limited, Electronics Department, in succession to Mr. J. W. Haig Ferguson, M.A.(Cantab.), A.M.I.Mech.E., A.M.I.E.E., A.M.I.Prod.E. who has been promoted divisional director.

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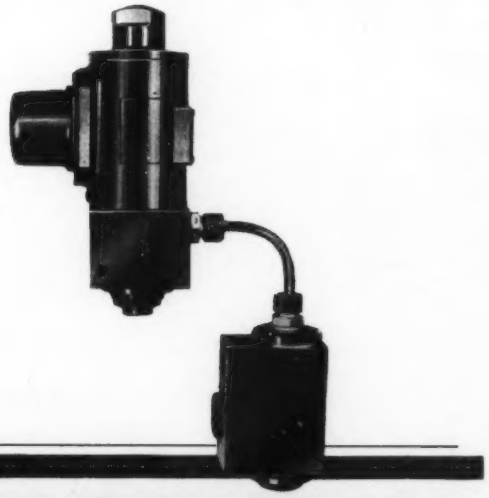

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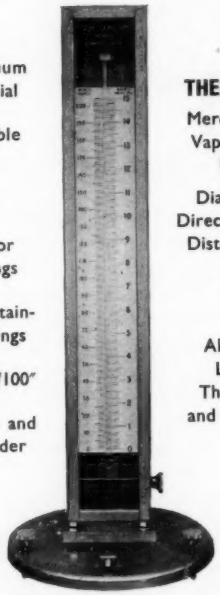

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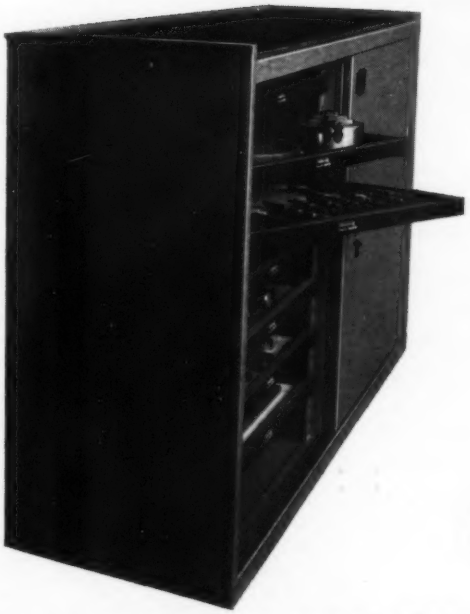

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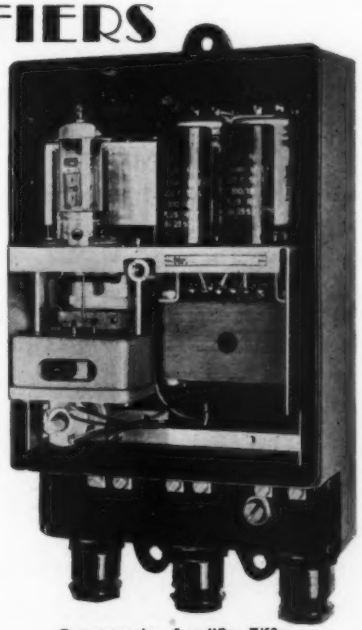

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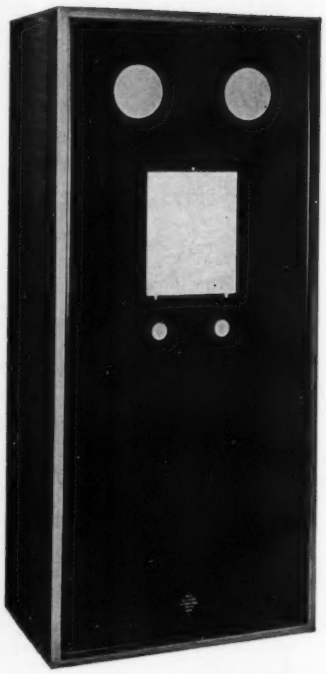

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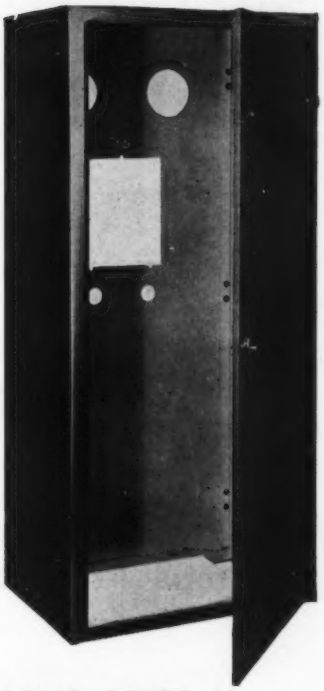

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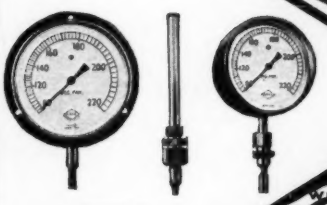

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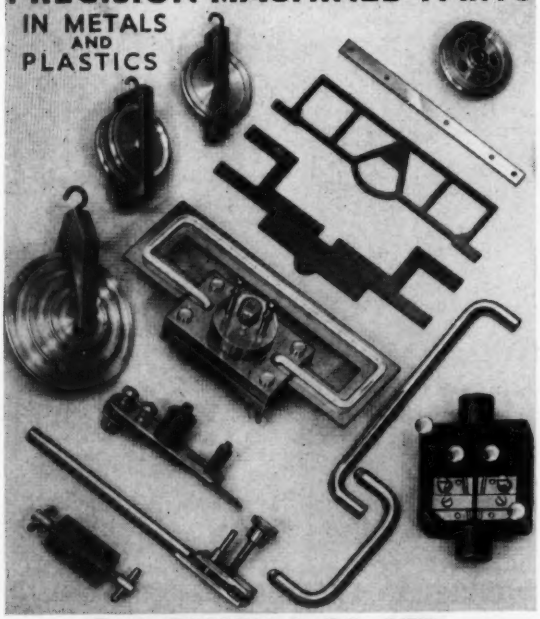

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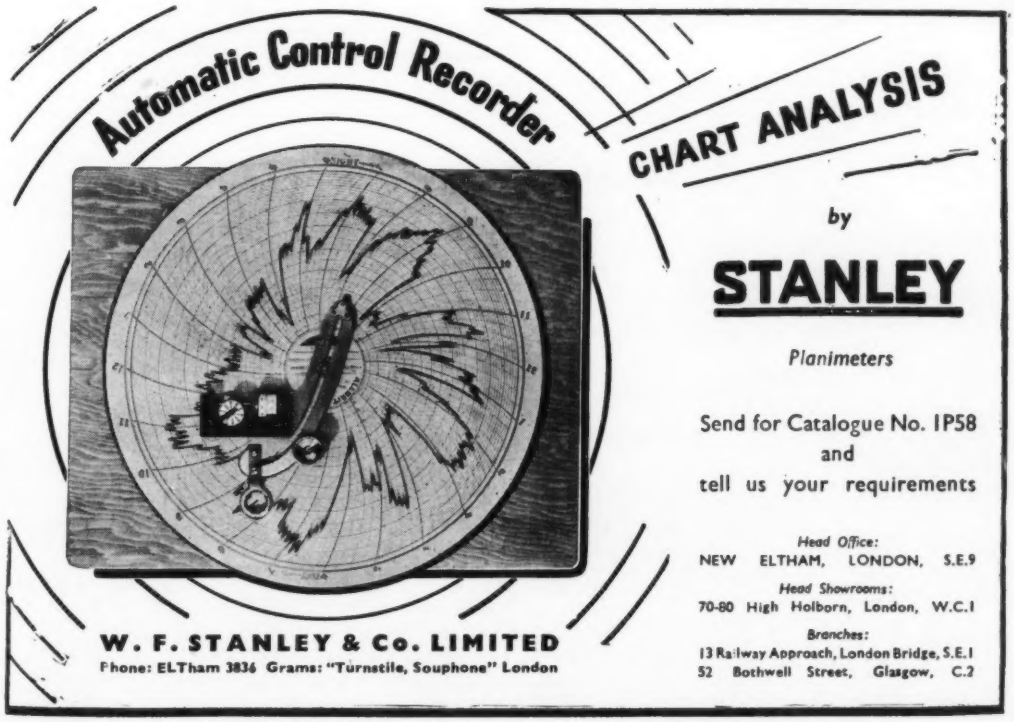

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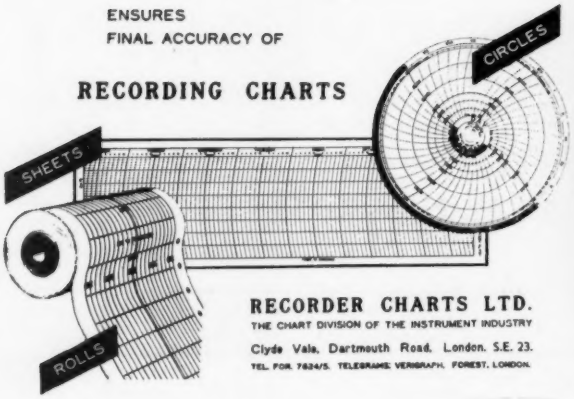

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784

860

July
July
July
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July
860
865

860